GEOLOGY

TUNNEL HILL AREA — Johnson and Pope Counties

Geological Science Field Trip

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A GUIDE TO THE GEOLOGY OF THE TUNNEL HILL AREA

By

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25 April 1987

GEOLOGICAL SCIENCE FIELD TRIPS are free tours conducted by the Educational Extension Section of the Illinois State Geological Survey to acquaint the public with the geology and mineral resources of Illinois. Each is an all-day excursion through one or several counties in Illinois; frequent stops are made for explorations, explanations, and collection of rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers in preparing earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students. A list of available earlier field trip guide leaflets for planning class tours and private outings may be obtained by contacting the Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820. (217) 244-2407 or 333-7372.

GEOLOGICAL FRAMEWORK

Geologic setting of the Tunnel Hill area. The Tunnel Hill field trip embraces a scenic area of diverse topography, relief, structure, and geological history. This portion of southern Illinois lies within the Shawnee Hills, also known as the "Illinois Ozarks" (fig. 1). The first part of the field trip route reaches northward to a point within five or six miles of the northern limit of the Shawnee Hills, but the remainder of the trip is more centrally located within this region.

A prominent ridge, composed largely of sandstone strata that resist erosion, extends across the Shawnee Hills from the Mississippi River to the Ohio River. The steep south face of the ridge, known as the Pennsylvanian escarpment, is formed by the eroded, exposed edges of strata that dip gently northward toward the center of the Illinois Basin (fig. 2). This ramp-shaped landform, characterized by a gentle slope on the "back" side of the ramp and a steeper face with exposed edges of bedrock layers on the other side, is called a cuesta (pronounced "kwesta"). The crest of the escarpment in the field trip area is also the drainage divide between the Saline River system on the north and the Cache River and Bay Creek systems on the south. These river systems both drain east and south into the Ohio River. Although most of the escarpment is highly dissected by streams, some flat upland remnants are preserved along the crests of narrow ridges. The highest mean sea level (m.s.l.) elevation along the ridge crest in the field trip area is slightly more than 780 feet at the house on the knoll on the southeast side of U.S. 45, 0.25 mile due east of the New Simpson Hill School. The lowest elevation in the field trip area is a little less than 370 feet m.s.l. on Bay Creek below the bridge about one mile southeast of Simpson. Total relief, therefore, in the field trip area is more than 410 feet.

Streams cutting into the resistant Pennsylvanian escarpment have steep gradients (bottom slopes) and narrow, V-shaped valleys. South of the escarpment, the underlying Mississippian strata are more easily eroded and little upland surface remains. This area is characterized by rounded hilltops and long hill slopes. Stream gradients are much lower than they are to the north, and the valleys are broader, having some flat areas along the bottom of large streams because of the deposition of sediments. The courses of the streams depend on the type and hardness of the bedrock through which they flow, as well as on small structural features. This erosional surface has been in the process of development since the end of the Pennsylvanian Period neary 280 million years ago and has been only slightly modified by the addition of a thin mantle of more recent surface deposits.

Bedrock strata exposed in the Tunnel Hill field trip area are derived from limy muds, silts, and sands that were deposited layer upon layer in ancient shallow seas that repeatedly covered the Midcontinent region beginning about 625 million years ago. Millions of years of deep burial consolidated these sediments into layers of limestone, dolomite, siltstone, sandstone, and shale now found in bedrock exposures and in well borings (fig. 3). Some coal and clay are also found in this sequence of sedimentary rocks. Sedimentary bedrock strata more than 12,000 feet thick have been deposited on the ancient, uneven surface of Precambrian crystalline rocks. These ancient rocks are mostly igneous or metamorphic rocks of granite and granite-like composition.

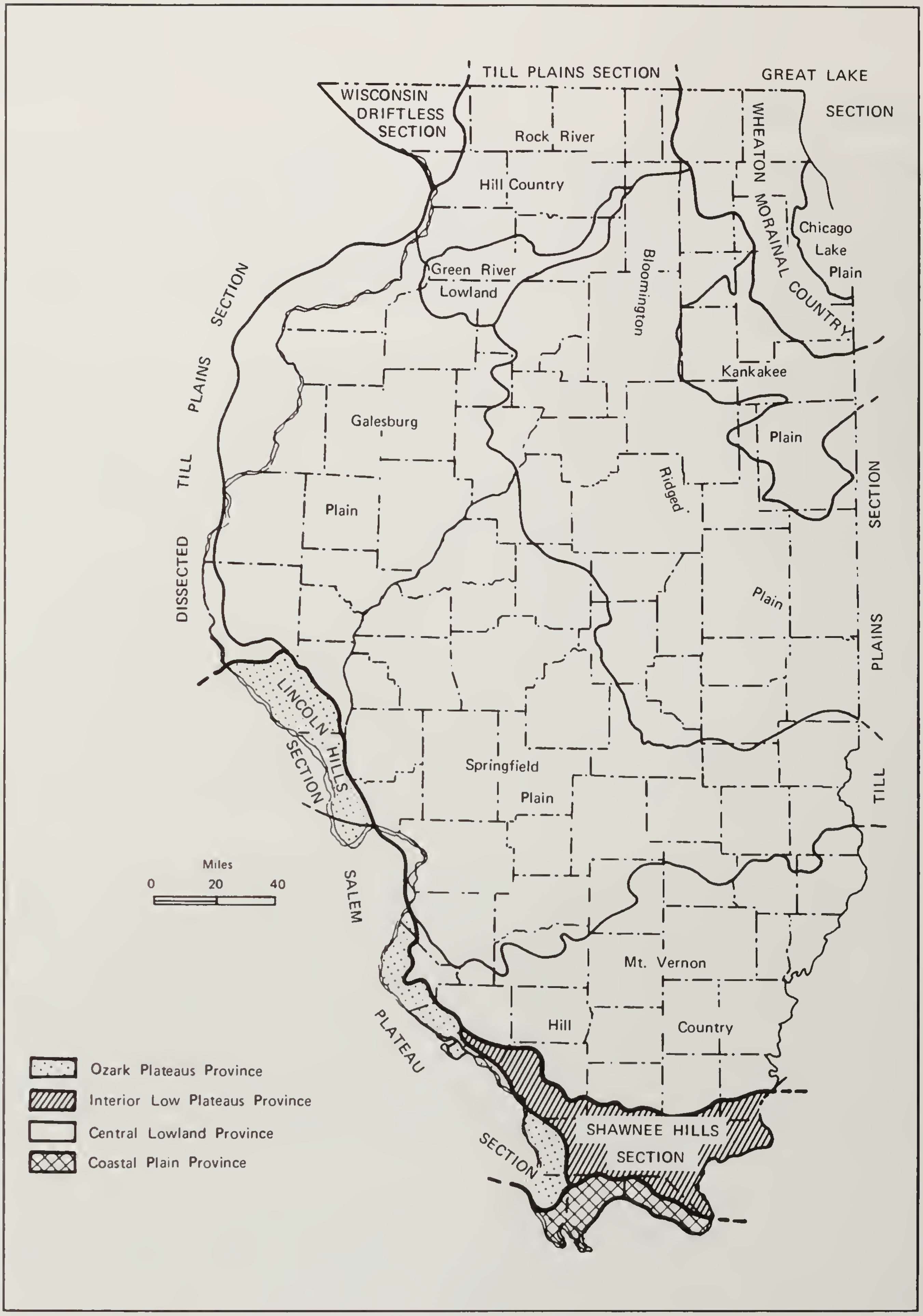


Figure 1. Physiographic divisions of Illinois

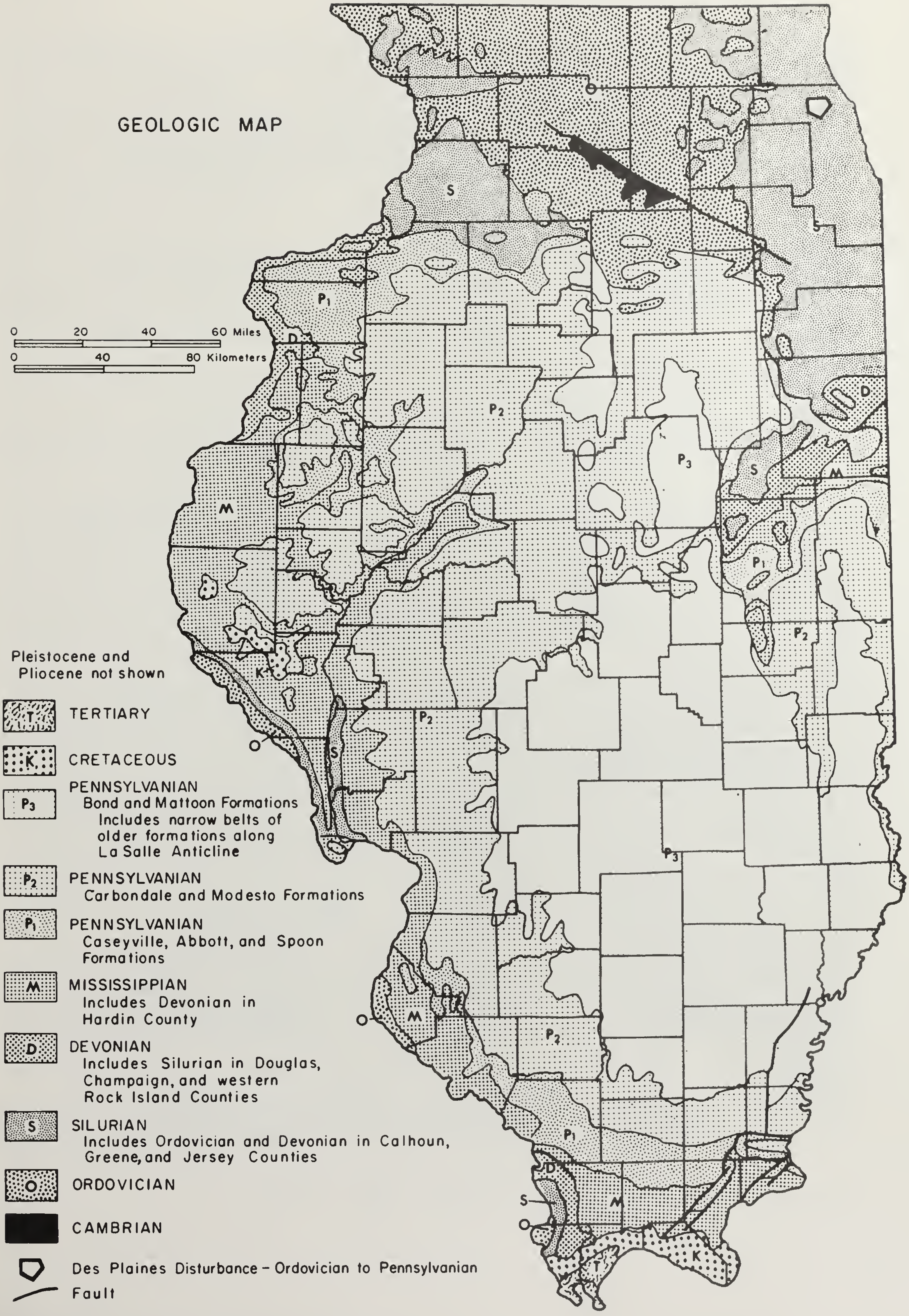
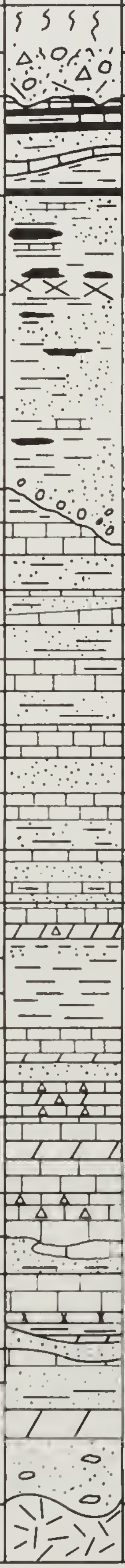


Figure 2. Geologic map of Illinois.

SYSTEM	SERIES	STAGE, GROUP	FORMATION	ROCK TYPE	THICKNESS (FEET)	DESCRIPTION
QUAT.	PLEIST.	Wisconsinan	Peoria and Roxana		0-25	Loess
		Illinoian			0-40	Till—clayey, sandy, pebbly
PENNSYLVANIAN	DESMOINESIAN	Kewanee Group	Carbondale		0 to 800	Shales, limestones, coals, sandstones
			Spoon			Shales, sandstones, limestones, coals, and clays
	ATOKAN	McCormick Group	Abbott			Sandstones, shales, thin coals
	MOR-ROWAN		Caseyville			Sandstones, shales
MISSISSIPPIAN	CHESTERIAN	Elviran Stage	Grove Church		0-67	Shale, limestone
			Kinkaid		75-160	Limestone, cherty shale
			Degonia		65	Sandstones, sandy shales
			Clore		125	Shales, limestones, some sandstone
			Palestine		40-80	Sandstones, shales
			Menard		140	Limestone, shale
			Waltersburg		60	Sandstone, shale
			Vienna		10-20	Limestone
			Tar Springs		75-85	Sandstone
		Hombergian Stage			220	Limestones, shales, sandstone
		Gasperian Stage			275	Sandstones, shales, limestone
	VALMEYERAN SERIES				8,500 to 10,300	Limestones, dolomites, sandstone, siltstone
	KINDERHOOKIAN SERIES					Shale
DEVONIAN	UPPER					Shale
	MIDDLE					Limestones, dolomites, sandstones
	LOWER					Chert, limestones, dolomites
SILURIAN	NIAGARAN-CAYUGAN SERIES					Limestones, dolomite, reefs
	ALEXANDRIAN SERIES					Limestones, chert
ORDOVICIAN	CINCINNATIAN SERIES					Shales, limestones, sandstone
	CHAMPLAINIAN SERIES					Limestones, dolomites, shales, sandstones, breccia, chert, gypsum
	CANADIAN SERIES					Dolomites, sandstones, chert
CAMBRIAN	CROIXAN					Sandstones, dolomites, shales
PRECAMBRIAN						Granite, other igneous and metamorphic rocks



ISGS 1978

Figure 3. Generalized geologic column. (Not to scale.)

The Tunnel Hill field trip area is about 50 miles southwest of the deep part of the Illinois Basin (figs. 4 and 5), an oval region of gentle downwarped bedrock strata underlying southern Illinois, southwestern Indiana, and western Kentucky. Strata exposed at the surface in the field tip area dip northeastward into the basin, where they have been found several hundred feet below ground. This simplified picture of the regional structure is complicated by folding and faulting, which to some degree affect a large part of the Shawnee Hills.

Nearly 300,000 years ago, massive, slow-moving continental glaciers reached their maximum extent during Illinoian glaciation (fig. 5) extending southward from Canadian centers of snow and ice accumulation into northern Johnson County. The glacier came within about two miles of reaching the ridge crest of the gentle north slope of the Pennsylvanian cuesta.

A few miles north of the glacial limit, the ice may have been several hundred feet thick. Very thin drift in southern Illinois seems to indicate that the ice only covered the region for a relatively short time interval. There is not much evidence of any end moraines, another indictor of relatively brief visit.

In front of the ice margin, melting ice formed a number of lakes that extended southward into the valleys of the north-flowing streams. Although the water level became high enough in areas to the west to top some of the low sags in the crest of the escarpment and flow to the south briefly, that does not appear to have happened in the field trip area. Instead, it appears that drainage from one or two of these meltwater lakes drained eastward across the front of the glacier into what is now the Saline River drainage system.

Although southern Illinois was not glaciated during Wisconsinan time, from about 75,000 up to 10,000 years before present (b.p.), extensive valley train deposits of sand and gravel were deposited along the Mississippi River. During the severe winters, as meltwater streams diminished, the valley trains dried out. The harsh, bitter, northwest winds swirled across these deposits winnowing out and carrying the fine sand and silt eastward to deposit them across the upland. These eolian deposits, called loess (pronounced "luss"), were layed down adjacent to the major rivers. Loess deposits tens of feet thick occur close to the large rivers, but thin rapidly eastward. Loess deposits in the field trip area range from about nine feet on the west to six feet or so toward the northeast. The thin, fragile soils of the area are developed in the relatively thin loess that mantles bedrock here.

Mineral production. Ninety-eight of the 102 counties in Illinois reported mineral production during 1985, the last year for which totals are available. The estimated total value of all mineral production in Illinois was more than $3.76 billion. Johnson County produced stone from two quarry operations. Fluorspar, lead, zinc, and silver were produced in Pope County, but the totals are included in the Hardin County production figures without any breakdowns available. Because of the few numbers of producing companies for each of the mineral commodities in both counties, the individual production figures are not given here in order to protect the confidentiality of each producer.

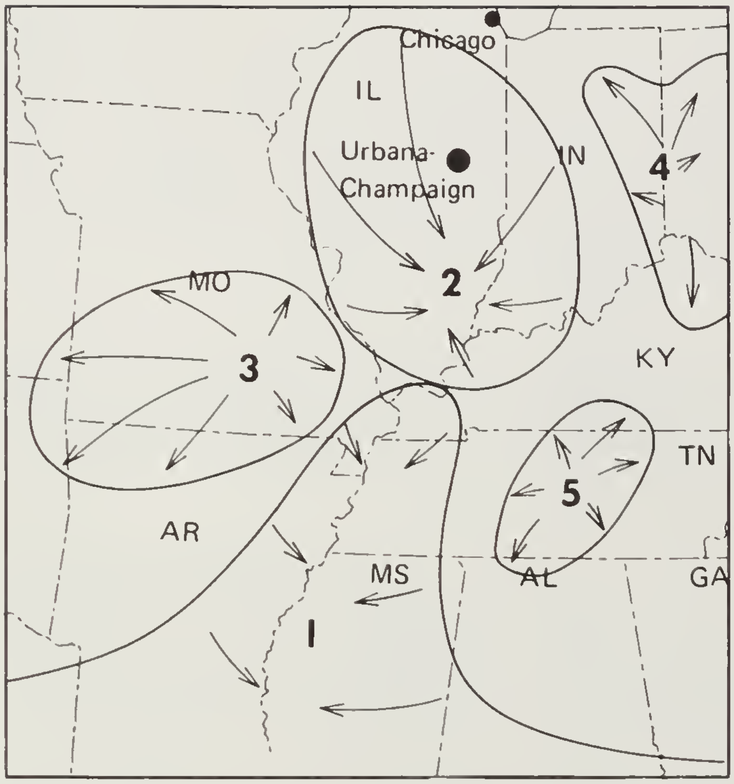


Figure 4. The location of the Mississippi Embayment and adjacent major structures: (1) Mississippi Embayment, (2) Illinois Basin, (3) Ozark Dome, (4) Cincinnati Arch, and (5) Nashville Dome.

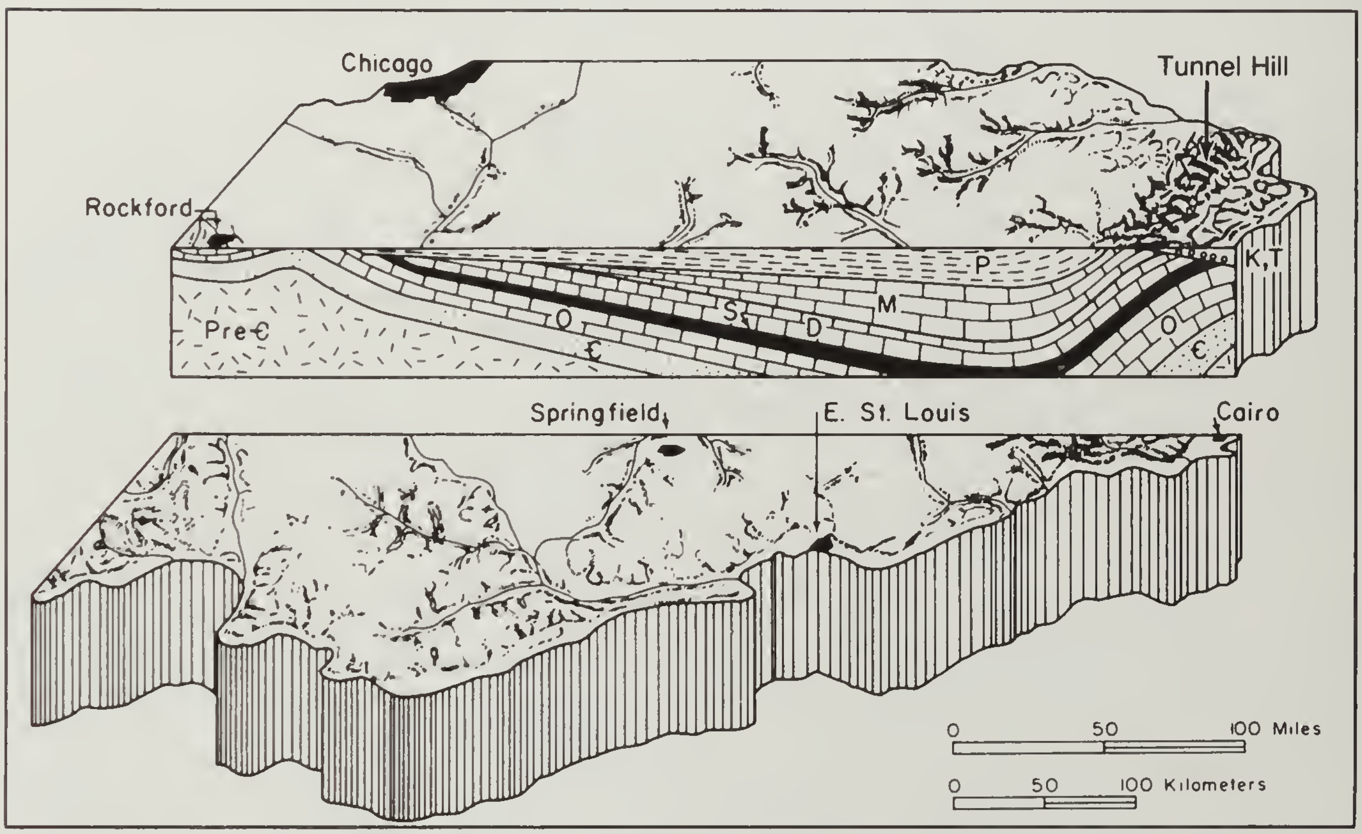


Figure 5. Stylized north-south cross section shows the structure of the Illinois Basin. In order to show detail, the thickness of the sedimentary rocks has been greatly exaggerated and the younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Pre-cambrian (Pre-C) granites. They form a depression that is filled with layers of sedimentary rocks of various ages: Cambrian (C), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). The scale is approximate.

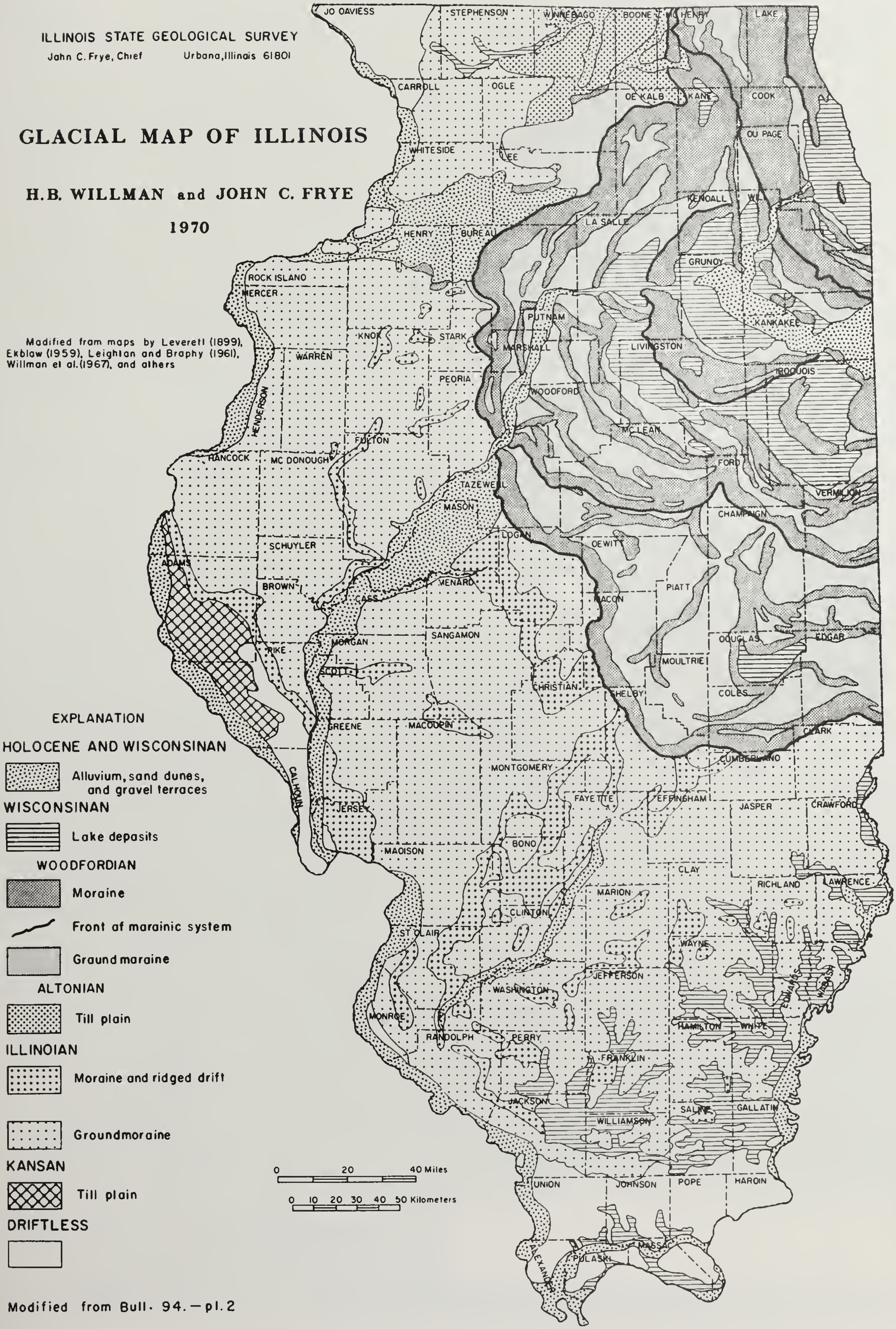


Figure 6. Glacial map of Illinois.

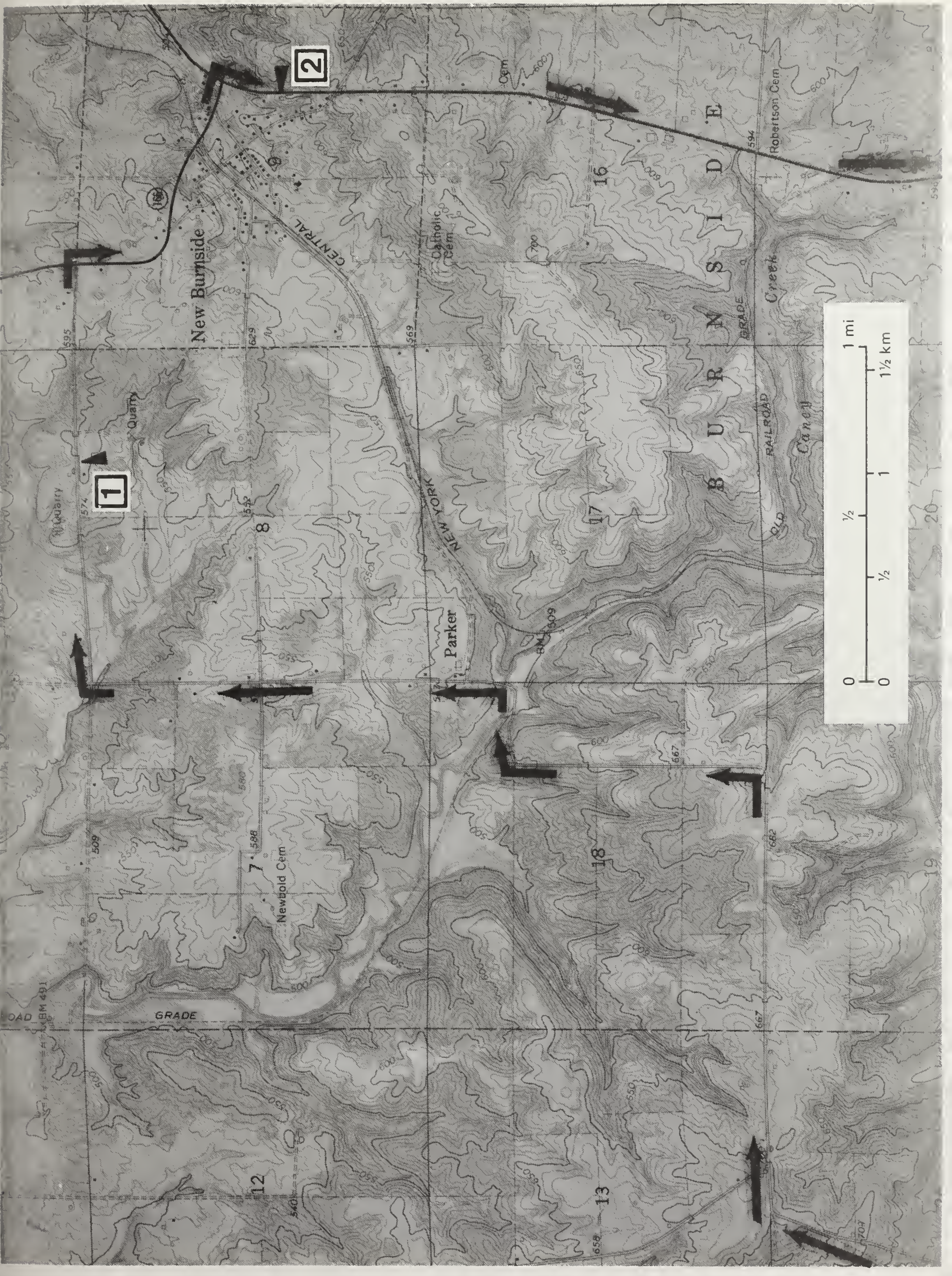
GUIDE TO THE ROUTE

NOTE: Please drive with your lights on while the caravan is moving--turn them off when we park. Drive safely and stay as close as you can to the car in front of you. PARK CLOSE.

Miles to next point	Miles from start	
0.0	0.0	Mileage figures begin at the entrance to the east parking lot of New Simpson Hill School. CAUTION: TURN LEFT (northwesterly) toward Tunnel Hill. The route for the next 0.1 mile is across some of the highest land surface (750 feet + m.s.l.) on the field trip.
0.55	0.55	Cross the Southern Railway (SRy) tunnel for which Tunnel Hill was named. The tunnel is approximately 600 feet long. The radio tower to the left is along the right of way.
0.05	0.6	The north tunnel portal is to the right below the road.
0.2	0.8	CAUTION: enter hamlet of Tunnel Hill.
0.3	1.1	Prepare to turn right.
0.1	1.2	TURN RIGHT (north) from Tunnel Hill Road (1600 N) on the Creal Springs Road (1075 E). The thin-bedded, platey, fine-grained sandstone exposed in the roadcuts is the Pennsylvanian Murray Bluff Sandstone Member (top of the Abbott Formation) (see fig. 7 in the STOPS section).
0.9+	2.1+	Route crosses the crest of the New Burnside Anticline, a northeast- to southwest-trending structure.
0.3	2.4+	Prepare to turn right.
0.1+	2.5+	TURN RIGHT (east) on to gravel road (1725 N; 1040 E).
0.5	3.0+	Approximate crest of New Burnside Anticline.
0.45+	3.5-	Approximate crest of New Burnside Anticline.
0.6+	4.1+	CAUTION: T-road from left (1800 N; 1150 E). CONTINUE AHEAD (east).


H I L L
Creek
23
24
19
Sugar
Creek
Woodside Cem
26
25
30
Tunnel Hill
35
36
31
START
Tunnel Hill Sch
CENTRAL
Sandburn
YORK
0
½
1 mi
0
½
1
1½ km

Miles to next point	Miles from start	
0.45-	4.55-	CAUTION: rough sandstone ledges across road. The sandstone is faulted here with the northwest side downthrown in relation to the southeast side. In other words, the younger strata of the Spoon Formation (NW) have moved downward to a position where they are just across the fault from older strata of the Abbott Formation. The fault trace is northeast (NE) to southwest (SW); dip of fault plane is 35° southeast (SE).
0.15+	4.7+	Approximate crest of the New Burnside Anticline.
0.55+	5.3-	At the road corner to the left, thin, platey sandstone of the Abbott Formation dips 4° to the south-southeast (SSE).
0.1-	5.4-	Approximate crest of the New Burnside Anticline.
0.45+	5.85	CAUTION: thick sandstone ledges in the ditch and across the road. Top of Murray Bluff Sandstone Member.
0.25	6.1	CAUTION: thick Murray Bluff Sandstone ledges in roadcut and across road.
0.15+	6.25+	CAUTION: concrete ford across Sugar Creek.
0.1+	6.4-	T-road from right. CONTINUE AHEAD (north). Area is known as Parker (City).
0.6+	7.0	CAUTION: crossroad (1950 N; 1300 E). CONTINUE AHEAD (north).
0.5	7.5	CAUTION: crossroad (2000 N; 1300 E). TURN RIGHT (east).
0.5	8.0	Sandstone ledges (lower Spoon Formation) across road.
0.15-	8.15-	Park along roadside.
		STOP 1. Discussion of coal mining and a mined lands reclamation project.
0.0	8.15-	Leave Stop 1. CONTINUE AHEAD (east).
0.3	8.45-	Sandstone ledges exposed in the ditch and the stream bank to the left. Earlier in this century, several small drift (tunnel) mines worked the New Burnside Coal in this vicinity.

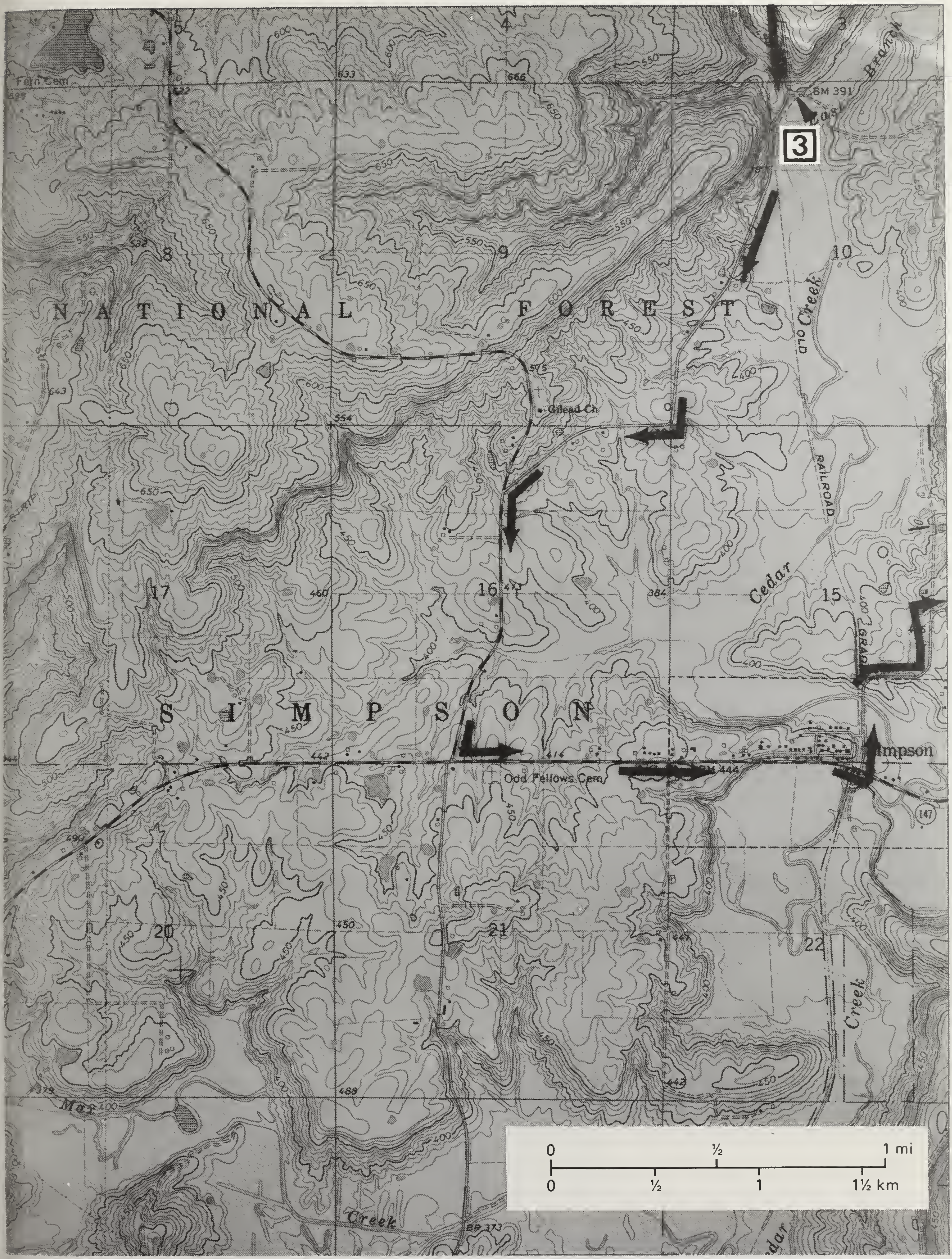


1
2
New Burnside
Parker
Quarry
Catholic Cem
Newbold Cem
Robertson Cem
Cem
NEW YORK CENTRAL
OLD RAILROAD GRADE
Cane Creek
B U R N S I D E
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
0.3	8.75-	STOP: 1-way; T-road. TURN RIGHT (south) on State Route (SR) 166.
0.1	8.85-	CAUTION: enter New Burnside village limits.
0.35-	9.2-	Roadcut through sandstone. Small drift mines reportedly operated in the small valley to the right just beyond this roadcut during the early days of settlement here.
0.15+	9.35+	CAUTION: (SRy) crossing.
0.2-	9.55-	STOP: 1-way. CAUTION: fast traffic. T-road. TURN RIGHT (southerly) on US 45.
0.1	9.65-	Prepare to stop on shoulder.
0.1-	9.75-	Park along roadside. CAUTION: fast traffic; look BEFORE opening your car door to get out! Stay OFF the highway!
		STOP 2. Discussion of Abbott Formation sandstone and New Burnside Anticline.
0.0	9.75-	Leave Stop 2. Use EXTREME CAUTION upon re-entering highway!
0.25	10.00-	Approximate crest of New Burnside Anticline. Note that sandstone bedrock is horizontal here.
2.2	12.2-	Ozark road to left. CONTINUE AHEAD (south) on US 45.
0.1	12.3-	Prepare to turn left. CAUTION: fast oncoming traffic.
0.15-	12.4+	CAUTION: TURN LEFT (south) on gravel road as US 45 curves right.
0.6	13.0+	Cross drainage divide. Drainage behind us (north) is to the north and east through Saline River and its tributaries to the Ohio River. Drainage ahead (south) is south and east via Bay Creek and its tributaries to the Ohio River.
0.1+	13.15	Top of Murray Bluff Sandstone.

Woodside Cem
20
22
Ozark
45
29
28
27
Radio Tower
Cem
32
33
34
Reynoldsburg
Camp Ondessonk
Cedar
Cedar Creek Cem
BOUNDARY
Creek
Ozark
S O N
F O R E S T
3
4
0
½
1 mi
0
½
1
1½ km

Miles to next point	Miles from start	
0.85	14.0	Hamlet of Reynoldsburg. Coal formerly was mined a little over 0.5 mile to the west of here. It was named the Reynoldsburg Coal (fig. 7), Abbott Formation.
0.05	14.05	T-road intersection. BEAR LEFT (south).
0.55+	14.6+	Descending upper part of the Pennsylvanian escarpment--the Pounds Sandstone Member of the Caseyville Formation.
1.3	15.9+	Park along roadside near the base of the escarpment at the entrance to small parking area to right below the road--Gum Springs.
		STOP 3. Caseyville Formation (lower Pennsylvanian) and Chesterian strata (upper Mississippian) exposed along and on either side of gravel road.
0.0	15.9+	Leave Stop 3. CONTINUE AHEAD (southerly) on gravel road.
0.05	15.95+	Cross Cedar Creek.
1.55	17.5+	STOP: 1-way; "r"-intersection. CAUTION: fast cross traffic. TURN LEFT (south) on Tunnel Hill/ Simpson Road.
0.1	17.6+	For next 0.15 mile the area is underlain by Mississippian limestone in which many small shallow sinkholes are developed.
0.75	18.35+	STOP: 2-way at off-set crossroad. CAUTION: fast cross traffic. TURN LEFT (east) on SR 147.
0.65	19.0	CAUTION: enter village limits of Simpson.
0.45	19.45	Prepare to turn left.
0.1+	19.55+	CAUTION: TURN LEFT (north) on gravel road at T-road intersection on the east side of Simpson.
0.2+	19.75+	CAUTION: 1-lane wooden bridge across Cedar Creek.
0.6	20.35+	CAUTION: CONTINUE AHEAD over the crest, then downhill and curve left (northerly) below the houses. Do NOT take the lane to the left near the crest of the hill spur.

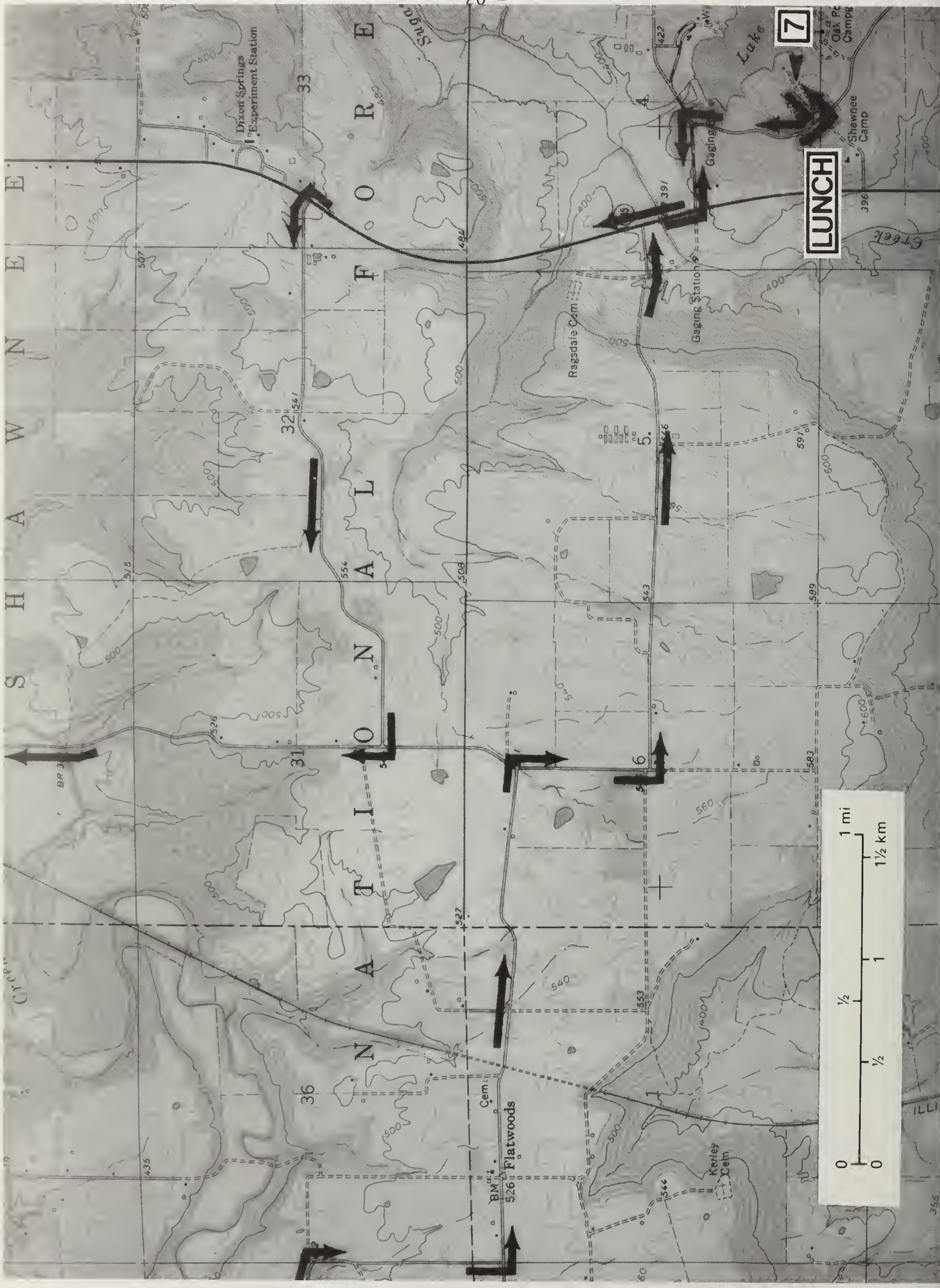

NATIONAL FOREST
SIMPSON
Fern Cem
BM 391
3
Gilead Ch
Odd Fellows Cem
Simpson
Cedar
Creek
RAILROAD
OLD GRADE
Max
Creek
BR 373
147
0
½
1 mi
0
½
1
1½ km

Miles to next point	Miles from start	
0.1	20.45+	Green and red shale of the Mississippian Degonia Sandstone exposed next to the road
0.15	20.6+	Negli Creek Limetone Member of the Mississippian Kinkaid Limestone exposed to the left of the road.
0.4-	21.0-	Park along roadside. CAUTION: do NOT block road but do NOT slip over edge of roadway fill.
		STOP 4. Mississippian Kinkaid Limestone exposed west of road. (Fossils may be collected here.)
0.0	21.0-	Leave Stop 4. CONTINUE AHEAD (northerly) up the hill.
0.05+	21.05	Greenish-gray and red shale of the upper Kinkaid is exposed in the ditch to the left.
0.05	12.1	Large slump blocks of Pennsylvanian Caseyville sandstone to the left.
0.4	21.5	Battery Rock Sandstone to right. Note the pronounced liesegang banding on the surface, the result of evaporation of mineral-laden groundwater. The iron salts were left behind and because they are more resistant to weathering than most of the rest of the host rock, they stand out in relief on the surface.
0.05	21.55	CAUTION: crossroad. CONTINUE AHEAD (northerly).
0.05-	21.6-	TURN RIGHT (southeast) and park in small lot.
		STOP 5. Scenic view of the field trip area from the top of the Trigg Lookout Tower.
0.0	21.6-	Leave Stop 5. TURN LEFT (southerly) at entrance to parking lot.
0.05-	21.65-	BEAR LEFT (southeasterly) at crossroad. There are a number of places ahead where you will have scenic views to the south and southeast. CAUTION: Do NOT become mesmerized and forget that there are precipitous cliffs very close to the road.
0.9-	22.55-	View to southeast from top of Battery Rock Sandstone bluff. The several large roofs in the distance to the southeast are at Robbs, slightly less than 2 miles away. The large conical-shaped hill north and east of Robbs is Millstone Bluff, one of our afternoon stops.

5
BM 764
Trigg Lookout Tower
646
4
SIMPSON
Johnson Ridge
Simpson
BM 46
Cem
Rock Springs Ch
BR 391
Robbs
BR 370
BR 381
6
Bay
Creek
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
0.3-	22.85+	CAUTION: descend hill over thick ledges of the Battery Rock Sandstone.
0.4-	23.25	TURN RIGHT (south).
0.6	23.85	Cross floodplain of Bay Creek; note width of floodplain here.
0.45	24.3	Cross Bay Creek
0.1+	24.4+	STOP: 1-way; T-rode intersection (Pope County - 2645 N: 015 E). CAUTION: fast cross traffic. TURN RIGHT (west) on SR 147.
0.25+	24.65+	Cross Bay Creek.
1.65	26.3+	Prepare to turn left.
0.1	26.4+	CAUTION: TURN LEFT (south) on gravel road (Johnson County 1175 N; 1620 E).
0.65+	27.05+	CAUTION: "r"-intersection. CONTINUE AHEAD (south) downhill.
0.2+	27.3+	Cross Bay Creek. Note how much more confined and narrow the floodplain is here than it was when we crossed it north of SR 147.
0.15	27.45	Resistant Mississippian Palestine Sandstone forms a 12 to 15 foot ledge at the base of the slope. It has been quarried just south of the road.
0.8+	28.3+	Park along roadside.
		STOP 6. View of meander neck of Bay Creek and noncompliance refuse disposal.
0.0	28.3+	Leave Stop 6. CONTINUE AHEAD (southeasterly).
1.3+	29.6+	CAUTION: T-road intersection (Johnson County 895 N; 1700 E). YIELD right-of-way. TURN LEFT (east).
0.55+	30.15+	T-road from left. CONTINUE AHEAD (east).
0.05-	30.2+	About 150 feet. About 150 feet east of this intersection is a series of short telephone poles extending from NNE to SSW. These are along the right-of-way of the Illinois Central Gulf (ICG) Railroad which is located in a tunnel beneath the line of poles. This tunnel is part of the ICG "Edgewood Cut-off" and is about 0.5 mile long.

Miles to next point	Miles from start	
0.9+	31.1+	CAUTION: unguarded T-road intersection (Pope County 2380 N; 050 E; Bull Pen Road). TURN RIGHT (south).
0.4	31.5+	CAUTION: unguarded, off-set crossroad (2350 N; 050 E). TURN LEFT (east) on Sheep Barn Road.
1.2	32.7+	CAUTION: rough washboard over sandstone ledges across road as you descend hill.
0.45-	33.15+	STOP: 1-way; T-road intersection. CAUTION: fast traffic. TURN RIGHT (south) on SR 145.
0.05+	33.2+	Cross Sugar Creek and prepare to turn left.
0.1+	33.3+	TURN LEFT (east) on Lake Glendale Road.
0.1	33.4+	Entrance to Lake Glendale Recreation Area, Shawnee National Forest.
0.15	33.6-	TURN RIGHT (south) at T-road intersection.
0.4+	34.0	TURN LEFT (northeasterly) toward Goose Bay Picnic Shelter.
0.15+	34.15+	Goose Bay Picnic Shelter parking area.
		STOP 7. Lunch
0.0	34.15+	Leave Stop 7. Retrace route to SR 145.
0.15+	34.3+	CAUTION: T-road intersection. TURN RIGHT (north).
0.4+	34.7+	STOP: 1-way; T-road intersection. TURN LEFT (west).
0.25	34.95+	STOP: 1-way; T-road intersection. CAUTION: fast traffic. TURN RIGHT (north) on SR 145.
0.1	35.05+	Cross Sugar Creek.
0.6+	35.7	Palestine Sandtone exposed along east side of roadway.
0.4	36.1	Prepare to turn left. Just ahead of the turn and to the right is the University of Illinois' Dixon Springs Agricultural Experiment Station.
0.1-	36.2-	TURN LEFT (west).


SHAWNEE
NATIONAL FOREST
Dixon Springs Experiment Station
LUNCH
7
Lake
Shawnee Camp
Gaging Station
Ragsdale Cem
Flatwoods
Cem
Kerley Cem
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
1.75	37.95	STOP: 1-way; T-road intersection. TURN RIGHT (north) on Bull Pen Road.
0.7	38.65	The conical-shaped hill about 2 miles to the NNE is Millstone Bluff.
0.25+	38.9+	Hayes Creek bridge.
0.9+	39.85+	Park along roadside.
		STOP 8. View of chevron fold along with west side of the ICG Railroad cut.
0.0	39.85+	Leave Stop 8. CONTINUE AHEAD (northeasterly).
0.4	40.2+	STOP: 1-way; T-road intersection. TURN RIGHT (east) on SR 147.
0.35	40.55+	Prepare to turn left.
0.1+	40.7	TURN LEFT (north) on the narrow gravel road toward an archealogical study area. Marker 462.
0.35	41.05	Parking area at abandoned quarry site.
		STOP 9. Abandoned Mississippian Kinkaid Limestone quarry in Millstone Bluff.
0.0	41.05	Leave Stop 9 and retrace route to SR 147.
0.3+	41.35+	STOP: 1-way; T-road intersection. TURN LEFT (east) on SR 147.
0.9	42.25+	CAUTION: approaching hamlet of Glendale.
0.2	42.45+	TURN LEFT (north and then northeasterly) at cross-road (2660 N; 225 E - Cedar Grove Road).
		CAUTION--portions of the road ahead are quite rough. Stay on main road unless directed other-wise.
3.8+	46.25+	Cedar Grove Social Brethren Church on right. CONTINUE AHEAD (northeasterly).
0.8+	47.05+	Another example of noncompliance refuse "disposal."
1.5	48.55+	CAUTION: T-road intersection (3070 N; 525 E). TURN LEFT (westerly) on McCormick Road from Cedar Grove Road.


Millstone Bluff
Quarry
Glendale
Robbs
Little Bay
Creek
Bay
ILLINOIS CENTRAL
Cem
9
8
0 ½ 1 mi
0 ½ 1 1½ km

Miles to next point	Miles from start	
0.6-	49.15+	CAUTION: ford across creek.
0.3	49.45	CAUTION: angle road from right on curve and hill (3125 N; 460 E). CONTINUE AHEAD (northwesterly) toward Bell Smith Springs on McCormick Road. Marker ahead - 447.
0.6+	50.05+	CAUTION: 2-lane wooden bridge over Bay Creek.
0.6+	50.65+	CAUTION: T-road intersection (3210 N; 385 E). TURN LEFT (southwesterly) on Bell Smith Road. Marker ahead - 848. Stay on main roads.
1.35-	52.0	U.S. Forest Service sign - Bell Smith Springs.
0.15	52.15	CAUTION: Y-intersection (right branch goes to Hunting Branch Picnic Ground). BEAR RIGHT (southwesterly) toward the Natural Bridge parking area and trail.
0.3	52.45	Red Bud Campground entrance to right. CONTINUE AHEAD.
0.2	52.65	Small parking area to left with information board.

STOP 10. Visit to the natural bridge, rock shelter, and springs at Bell Smith Springs, Shawnee National Forest.

FIELD TRIP - CONTINUE AHEAD for parking directions.

0.15-	52.8-	This is the far end of the loop turnaround and roadside parking. You can get to the Natural Bridge Trail without going all the way back up to the information board--the trail can be picked up from the south side of this loop.

BE EXTREMELY CAUTIOUS NEAR THE CLIFFS -

THE FIRST STEP CAN LOOSEN YOUR TEETH...

OR WORSE:

This is the last stop on the Tunnel Hill field trip. To get home from here:

1) Retrace route to McCormick Road, 2.15 miles northeast.


22
23
Teal Pond
Beames Cem
BM
Branch
E S T
Creek
Watkins Ford
526
26
Hunting
Griffin Cem
Bay
Smith Springs
Scenic
10
END
Natural Bridge
34
35
BM
742
Spring
Branch
Creek
Peter Cave
Cedar Grove Ch
Cem
0
½
1 mi
0
½
1
1½ km

Miles to next point	Miles from start	
		2) Turn right (south) for Eddyville, Glendale, etc. - OR - Turn left (north) for 1.45 miles to junction: right for Burden Falls and Delwood and Harrisburg; left for McCormick, Ozark, Vienna, Tunnel Hill, New Burnside, Creal Springs, Marion etc.
		3) If all else fails, the route map on the back cover should help you get to a main road. Good luck!

FIELD TRIP STOPS

STOP 1. Discussion of coal mining and reclamation of mined lands currently being carried out at this locality [N edge NW 1/4 NE 1/4 NW 1/4 NE 1/4 extended Sec. 8, T. 11 S., R. 4 E., 3rd P.M., Johnson County; Creal Springs 7.5-minute Quadrangle (37088E7)].

Geologists working in this area during 1916 noted the presence of old shaft and slope mines within a half mile of this locality, none of which appeared to have been worked for some time. Others noted the presence of small idle or abandoned coal stripping operations in this vicinity during the early 1950s. During April 1956, a strip coal operation began south of the road here. Two bulldozers were used to uncover the upper coal after the overlying sandstone had been blasted to break it up. A 1/2 cubic yard power shovel was used to load the coal into stake-bed farm trucks for the short haul to a railroad siding at New Burnside. Using three trucks to haul the coal, the operators were able to load about eight rail cars per day.

Although a considerable amount of this coal was under very thin cover, or overburden (15 feet or less), the coal was firm and essentially unweathered. This mine produced less than 1,900 tons of coal and closed after working only about three months. The mined-out-area is now undergoing rehabilitation through a program funded by the Illinois Abandoned Mined Lands Reclamation Council.

The sequence of rocks that have been exposed here, and that are even now partially exposed just to the north in Section 5, is as follows (from the top downward):

PENNSYLVANIAN SYSTEM
  Kewanee Group
    Spoon Formation
        Granger Sandstone Member - Sandstone, light gray, fine-grained; irregularly interbedded with 10 to 15 percent shale partings which are more numerous in upper portion; 18 feet 6 inches

        Conglomerate, gray, sandy, and ferruginous; contains 1/4 to 1 inch well rounded sandstone and shale pebbles; 1 foot 6 inches

      Shale, gray, sandy, interbedded with carbonaceous shale; 1 foot

      New Burnside Coal Member - normally bright-banded as seen in abandoned strip mine; (locally may be 3 feet 6 inches or slightly more). 3 feet

      Covered interval with some sandstone float pieces noted in lower 3 feet; 6 feet 6 inches

      Shale, gray, sandy; 11 feet 6 inches

Conglomerate, very ferruginous and hard, red color conspicuous; sandstone, shale, and some chert pebbles up to 3 inches in diameter embedded in a sandy matrix; disconformable with coal below; 2 feet

Bidwell Coal Member - Coal, blocky, beds 1/8 to 1 inch thick interbedded with approximately 25 percent coaly shale; 1 foot 5 inches

Coal, blocky, bright, interbedded with gray clay and coaly shale; 1 foot 3 inches

Clay, light gray, sandy, badly weathered; base concealed; 3 feet +

Total thickness exposed - 48 feet 8 inches

STOP 2. Discussion of New Burnside Anticline [W edge SW 1/4 NW 1/4 NE 1/4 SE 1/4 Sec. 9, T. 11 S., R. 4 E., 3rd P.M., Johnson County; Creal Springs 7.5-minute Quadrangle (37088E7)].

The highway cut has exposed Pennsylvanian sandstone, siltstone, and shale along the north limb of the New Burnside Anticline, an upwarp of bedrock strata. This structure, however, is asymmetrical, that is, the north limb, or flank, is more steeply tilted than the south flank. The anticline is the result of folding in Pennsylvanian and older strata due to compressional forces exerted from the southeast. The folding, and faulting, which has been mapped elsewhere along the structure, have been shown by seismic geophysical records to be related possibly to thrust-faulting connected with the Fluorspar District, a few miles to the east-southeast.

Strata exposed in the roadcut become progressively older as one moves uphill toward the center of the anticline, near the top of the hill. Sandstone strata on the north flank have an average dip of 25 to 30 degrees to the northwest. Rocks flatten out as one drives up the hill, so that when you are near the top of the hill, the strata are horizontal, indicating that you are at the crest of the structure. The more gently dipping south flank is not well exposed in this vicinity.

The youngest sandstone unit, about 15 to 25 feet thick, exposed near the bottom of the roadcut is unnamed, but occurs near the base of the Spoon Formation. It is stratigraphically lower, and therefore older, than the Bidwell Coal discussed at Stop 1. The next sandstone exposed in the roadcut as you proceed up the hill, about 20 to 30 feet thick, occurs in the upper part of the Abbott Formation and may be a correlative of the Murray Bluff Sandstone Member. The next older sandstone, about 30 feet thick, is not well exposed here, but is found in the ditch, if you look carefully. This sandstone is extremely bioturbated, that is, it contains many fossil burrows of marine animals of various types. The oldest sandstone here appears to occur near the middle of the Abbott Formation and is flat lying at the crest of the New Burnside Anticline. This sandstone is thick-bedded to massive appearing and 10 to 15 feet plus thick. The maximum total thickness of strata exposed along this roadcut is about 150 feet.

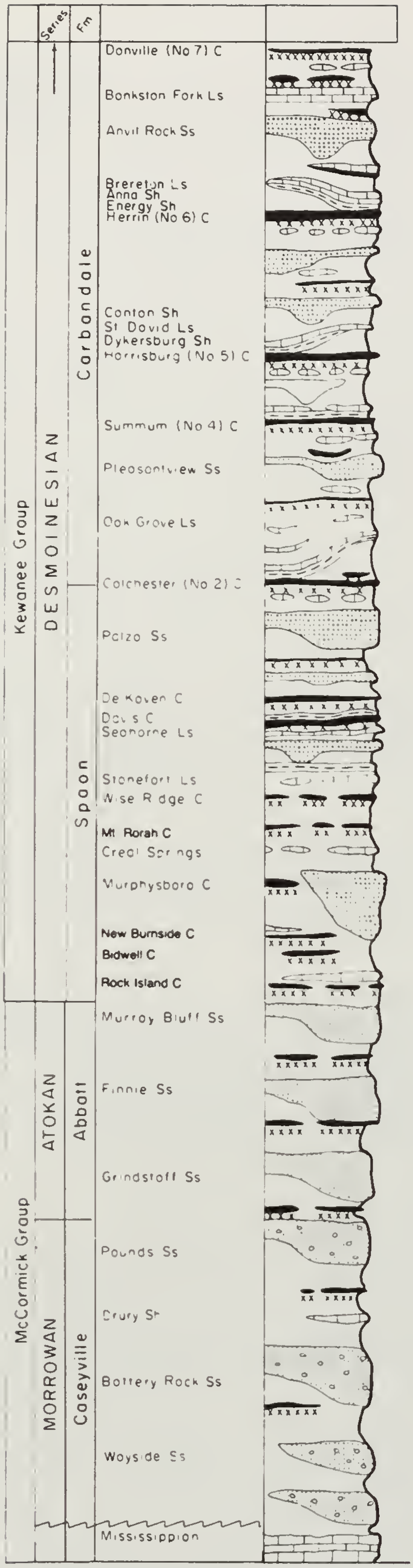


Figure 7. Classification of the Pennsylvanian System in southern Illinois. In the graphic column, blank space indicates gray shale. (Modified from Willman et al., 1975) (not to scale.)

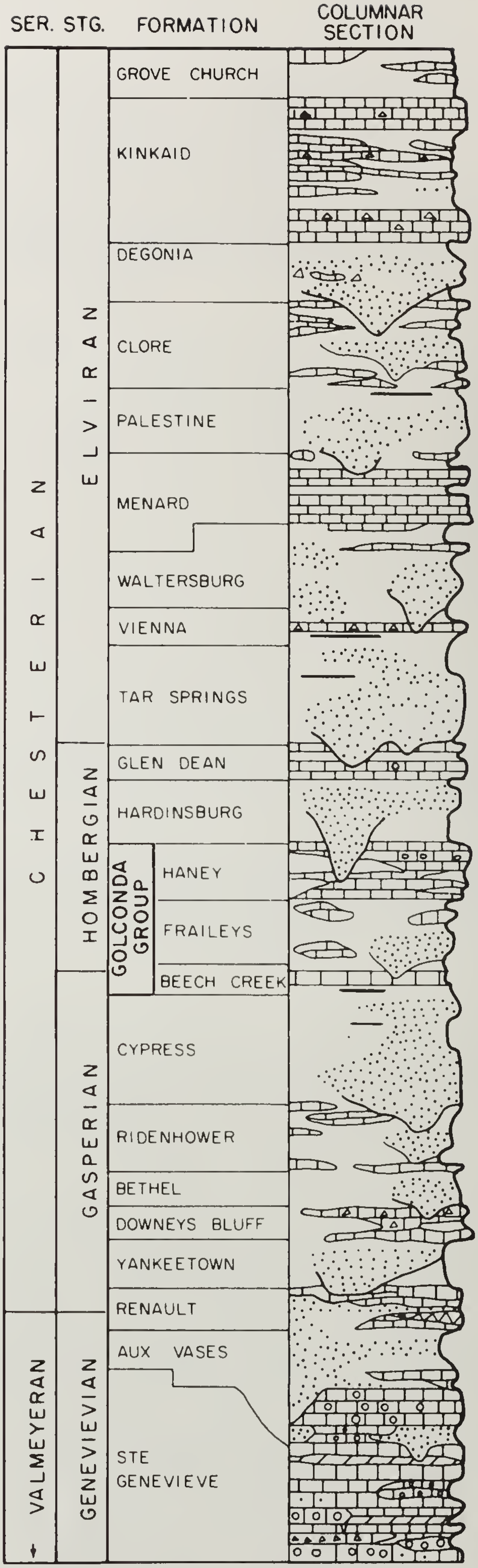


Figure 8. Columnar section of the Chesterian Series (after Swann, 1963) in the field trip area. In the columnar section, the blank areas are shale. (Not to scale.)

STOP 3. Lower Pennsylvanian and upper Mississippian strata exposed along the county road and in the valley wall of Cedar Creek at Gum Springs [SW 1/4 SE 1/4 SW 1/4 Sec. 3, and NW 1/4 NE1/4 NW 1/4 Sec. 10, T. 12 S., R. 4 E., 3rd P.M., Johnson County; Bloomfield 7.5-minute Quadrangle (37088D7)].

Sandstones and shales of the lower Pennsylvanian Caseyville Formation and limestones and shale of the upper Mississippian Kinkaid Limestone (Formation) have been brought to the surface by compressive forces acting within the earth. That bending and breaking took place during late Pennsylvanian time or early Permian time and produced the northeast to southwest-trending McCormick anticline and fault structure. Due to slumping and overgrowth, it is difficult to find good exposures of these strata to work with in this area.

A general description of the strata exposed in this vicinity follows (from the top, downward):

PENNSYLVANIAN SYSTEM

McCormick Group

Abbott Formation

Reynoldsburg Coal Member - varies in character, appearance, and thickness (up to 3 feet in this area). In some places it is closely related to cannel coal (composed largely of plant spores and pollen grains which give it a waxy appearance and feel and make it easy to ignite). Known only from this part of Illinois and perhaps western Kentucky. Numerous old, abandoned mines farther up Cedar Creek to the west mined this coal.
3 feet

Underclay - clay, not laminated, light gray, frequently with iron staining, sandy, with root traces; base concealed;
1 foot 9 inches +

Covered interval - 3 feet ±

Caseyville Formation

Pounds Sandstone Member - sandstone, light gray, hard, resistant, medium- to coarse-grained, with numerous quartz pebbles giving conglomeratic appearance locally, massive, cliff former; precipitation of iron salts on exposed surface has produced liesegang banding; route came down across this unit about 1.25 miles back; 70 feet ±

Drury Shale Member - complex unit of silty or sandy shales, siltstones and fine-grained, flaggy sandstones, and massive lenticular sandstones. In the ditch on east side of the road, about 0.15 ± mile northward up the hill, these rocks are exposed, essentially horizontal bedded. Beginning about 0.1 ± miles to the north, and extending southward for several tens of feet, the dip increases rapidly to 40 - 55° northwest and the sandstone becomes highly fractured and probably faulted;
60 to 70 feet

Battery Rock Sandstone Member - very similar to Pounds Sandstone; generally medium-grained but locally is coarse-grained and conglomeratic with quartz pebbles; iron cement precipitated from iron salts in solutions moving through the sandstone produced liesegang banding locally; 60 feet ±

Wayside Sandstone Member - sandstone, light gray, conglomeratic with quartz pebbles, iron cement in part; interbedded with gray, sandy shale and shaly sandstone; west of the road along Cedar Creek is a nearly horizontal ledge of this sandstone that is cross-bedded and contains lenses of quartz pebbles; 25 feet +

MISSISSIPPIAN SYSTEM
Chesterian Series
Kinkaid Limestone
Cave Hill Shale Member - shale siliceous, thinly laminated, greenish-gray and reddish-purple; steeply dipping to northwest about 55°; 30 feet +

Covered interval - alluvium.

STOP 4. Mississippian Kinkaid Limestone exposed in the west side of road [NW 1/4 SE 1/4 NE 1/4 NW 1/4 Sec. 14, T. 12 S., R. 4 E., 3rd P.M., Johnson County; Glendale 7.5-minute Quadrangle (37088D6)].

The Kinkaid Limestone is exposed along the western side of the road in the ditch and in low roadcuts. Some of the small rills and gullies to the west and northwest also have small exposures, but generally, because of slumping and overgrowth, it is difficult to get anything more than small, disconnected exposures of this formation in the field trip area.

Fossil collecting at this stop is fairly good (note the attached fossil plate of Mississippian invertebrate fossils at the end of the "Mississippian Deposition" appendix), is of easy access, and is much less dangerous than elsewhere in this vicinity.

MISSISSIPPIAN SYSTEM
Chesterian Series
Kinkaid Limestone
Cave Hill Shale Member - several feet of grayish-green shale of the upper part of this member are found up the hill and just around the curve. Below the greenish-gray shale is a zone of variegated red and green shale which is a prominent marker bed over a considerable geographic area--remember, this was noted at Stop 3. The Cave Hill Shale contains a number of limestone and dolomite beds of varying thickness; the thickest here is about 5 feet in outcrop. One of the brownish-gray, fine-grained limestones near the upper part of the sequence is quite fossiliferous here, having very good specimens of <u>Archimedes</u> with the fronds still attached. About half way down the hill the stone tends to be somewhat lithographic, that is, it is a very fine-grained crystalline limestone; 100 feet ±

Negli Creek Limestone Member - mostly brownish-gray, masive to thick-bedded, fine-grained limestone that is somewhat cherty in the upper part; tends to be lithographic in the lower part; large gastropod fossils near middle; 30 feet ± base covered

STOP 5. Scenic overlook of the Shawnee Hills/Illinos Ozarks from the Trigg Lookout Tower [Near Center North Line SW 1/4 NW 1/4 SE 1/4 Sec. 11, T. 12 S., R. 4 E., 3rd P.M., Johnson County; Glendale 7.5-minute Quadrangle (37088D6)].

The Trigg Lookout Tower is located on top of the lower Pennsylvanian escarpment. A Bench Mark adjacent to the tower base has an elevation of 764 feet mean sea level (m.s.l.). To the east and west are excellent views of the cuesta--from the abrupt south-facing scarps (mostly tree covered) the ground slopes gently north and northeastward into the Illinois Basin. Note the difference in the topography in the northern hemisphere that you are looking at compared to the southern hemisphere. The thick limestone and shale bedrock strata underlying the area to the south yield a more gentle, rolling land surface. Although from up here on top of the platform, the land surface appears to be gently sloping to the north, remember that it is underlain by thick resistant sandstone strata that produce sharp cliffs when streams cut down through them. The tree cover masks much of the rugged character of the area, as you will note later along the route. Note the prominent Millstone Bluff about 3 miles east-southeast of the tower.

Class project. The tower deck is approximately 60 feet above the ground here. The main road below the tower trends approximately northeast-southwest. If the air were clear enough and your eyes were sharp enough (even with field glasses or a good telescope), how many of the following places could you see from the tower deck? The following distances and compass directions are approximate. You will need to consult topographic maps to learn the m.s.l. elevations of the various places noted in order to work out the problem. It will help to make profiles along the line of sight to the various localities from the tower site: Stonefort - 9 miles NNE; Carrier Mills - 15 miles NE; Harrisburg - 19 miles NE; Eddyville - 8 miles ENE; Glendale - 4 miles SE; Robbs - 3 miles SE; Lake Glendale - 6.5 miles SE; the Ohio River -18 miles SE; Simpson - 2 miles SW; Vienna State Prison - 7 miles SSW; Vienna - 10 miles SW; Southern Illinois Electric Cooperative power plant - 15 miles NW; Marion - 20 miles NW; Creal Springs - 10 miles NW; New Burnside - 6.5 miles NNW; Reynoldsburg - 3 miles NW. You can add an additional problem to your study of the area by using a compass to be more accurate in determining directions (why would it not be a good idea to work from the upper deck of the tower with your compass for this problem?). You can determine the compass directions by referring back to the topographic maps and then using your protractor. This would be a splendid exercise when the weather is too inclement to go outdoors to enjoy the scenery here.

STOP 6 View of meander neck along course of Bay Creek and noncompliance refuse disposal [NE 1/4 NE 1/4 NE 1/4 NW 1/4 Sec. 35, T. 12 S., R. 4 E., 3rd P.M., Johnson County; Glendale 7.5-minute Quadrangle (37088D6)].

Bay Creek has eroded its valley some 150 feet below the general upland level in this vicinity. The valley is wider in areas where the stream encountered softer, more easily eroded bedrock, such as, shale, siltstone, and limestone. On the other hand, the valley is more restricted where the stream has cut into more resistant bedrock layers, such as sandstone.

Over countless years, Bay Creek and its tributaries cut down through the softer strata and into resistant sandstone. The slip-off slope, across which we've been traveling since crossing the bridge, is upheld by resistant Mississippian Palestine Sandstone, noted both on the northwest side of the bridge where the creek has been recently active in eroding and producing the bluff we descended to cross Bay Creek. On the southeast side of the valley, Palestine Sandstone is also present at the base of the valley slopes.

To our left (northeast), Bay Creek is close to the base of this steep slope. Depending on the foliage, you may be able to see some meanders to the northeast. At some time in the not too distant past, Bay Creek has been close to the bottom of the steep slope on the right (southwest). Eventually, if man were not to interfere with Nature by repairing the road, etc., Bay Creek would erode through this narrow neck of land to produce a shorter more direct route to the Ohio River.

Disposal of refuse materials, such as those seen here, must be aesthetically acceptable to people in this area. Apparently the hope is that the junk will migrate down slope where Bay Creek can pick it up during floodtimes and carry it out of the area. Out of sight--out of mind. Actually there are laws against this type of indiscriminant, unprotected, private dumping, but they need to be enforced.

Little thought has been given to the dire consequences of such poor planning. Not only is this refuse a blemish on the countryside, but pollutants also can enter the groundwater system through porous strata exposed in this area, and through joints and cracks in the bedrock. In addition, the surface water will be polluted and need expensive processing in order to make it potable for individuals and communities downstream. Pollution may also affect the fish and other animals and plants in Bay Creek. Think of the cost to you, me, and our descendants of cleaning up countless messes such as this. You will see other examples of this unconcern for our environment on the field trip.

We all have a stake in this--we must educate others to the dangers of this type of refuse disposal; we must make certain that adequate, approved, safe disposal sites are available to all; and that laws against indiscriminant dumping are enforced.

STOP 7. Lunch at Goose Bay Shelter and picnic area, Lake Glendale [NE 1/4 SW 1/4 SW 1/4 SE 1/4 Sec. 4, T. 13 S., R. 5 E., 3rd P.M., Pope County: Glendale 7.5-minute Quadrangle (37088D6)].

The dam for Lake Glendale was constructed in the 1930s. The 80-acre lake itself, which has one of the lowest lake sedimentation rates in Illinois, is about 0.8 of a mile long and about 0.35 of a mile wide.

STOP 8. View of chevron fold along the west side of the Illinois Central Gulf Railroad cut at Robbs [SW 1/4 NW 1/4 SW 1/4 SE 1/4 Sec. 19, T. 12 S., R. 5 E., 3rd P.M., Pope County; Glendale 7.5-minute Quadrangle (37088D6)]

CAUTION: Do NOT get too close to the edge of the railroad cut--it is very steep and unstable. Do NOT attempt to walk in from the ends of the cut--it is PRIVATE PROPERTY and extremely dangerous!

Bedrock exposed along the railroad cut belongs to the Mississippian Clore Formation which is composed of two members in outcrop here: the upper Ford Station Limestone Member and the Tygett Sandstone Member that occurs near the middle of the Clore. Nearly 100 feet of the Clore is exposed along this railroad cut. The Ford Station Limestone is a sequence of alternating shale, sandstone, and limestone units of varying thicknesses and character, some of which are fairly fossiliferous. The Tygett Sandstone Member occurs near the middle of the formation and is a fine-grained sandstone that contains abundant plant debris near the top, including _Stigmaria_ roots and rootlets in place.

The bedrock structure here is of particular interest, especially because this is one of the relatively few places in Illinois where one can readily see folded and/or faulted strata. The view from here of the west side of the railroad cut shows interbedded sandstones and shales of the Mississippian Clore Formation sharply folded upward into a small inverted "V" shape. The structure has the appearance of an asymmetrical anticline from a distance, but closer observation discloses the sharp crest. The inaccessibility of the crest, however, makes it difficult to ascertain the strike (direction) of that crest--it appears to be at least N 55° W, but may be as much as N 70° W. The fold is approximately 125 feet wide and shows a structural height of 15 to 20 feet at the crest, being nearly perpendicular to the tracks. From the vicinity of the SR 147 overpass, approximately 0.4 miles to the north (right), bedrock strata rise gradually southward through the railroad cut, finally steepening rapidly to 25 to 30° toward the crest. Although the rock layers in the south limb also have steep dips of 25 to 30°, the steepening is much more rapid than on the north side of the crest.

Associated with the chevron fold are several small thrust faults and flexures. Thrust faults near the center of the structure on both sides of the track follow bedding planes in the shale, then steepen at the crest and shear across bedding surfaces. North of the crest on the west side, there appears to be a steep, north-dipping reverse fault that has off-set the sandstone 4 or 5 feet. The sandstone is shattered in that location and the exposure is not clean.

Clearly, this structure has resulted from horizontal compressive forces that acted within the Earth _after_ the sediments had become lithified.

STOP 9. Abandoned Mississippian Kinkaid Limestone quarry in Millstone Bluff [NW 1/4 SE 1/4 NW 1/4 NW 1/4 Sec. 20, T. 12 S., R. 5 E., 3rd P.M., Pope County; Glendale 7.5-minute Quadrangle (37088D6)].

CAUTION: The quarry face AND slopes above your head are unstable--look up BEFORE you pull some specimen from the face. Make sure no one is standing above you at any time. Do NOT get close to the quarry edges if you are working up the slopes, because the edges can give suddenly, even a foot or two back from the lip.

The rocks exposed in this abandoned quarry are from the same sequence of which we only saw small portions at Stop 4. There is a thin, persistent shale about 6 to 7 feet above the main quarry floor. Everything above this shale parting in the quarry is part of the Cave Hill Shale Member of the Kincaid Limestone. The top of the quarry face is nearly 37 feet above the shale parting. The contact between the Kinkaid Limestone and the overlying, lowermost Pennsylvanian strata is perhaps 10 feet farther up the slope, but is covered by slump. Above that position are float pieces of Pennsylvanian sandstone. The topmost units in the Kinkaid, a greenish-gray shale and the green and red varigated shale, appear to be completely covered by slumping above the quarry face.

In studying this exposure, you will gain some understanding of the problems encountered in working out the geology of this part of Illinois, and why the Cave Hill Shale Member was so poorly exposed at Stop 4, or elsewhere in this area. Although several of the limestones appear to be thick-bedded or massive, they are argillaceous (clayey) and thus, relatively weak. Note also, that the slopes here around Millstone Bluff are not appreciably different from those at Stop 4. Some of these units are fossiliferous, but don't risk life and limb to get some. Worse yet, don't risk your neighbors.

STOP 10. Visit to the natural bridge, rock shelter, and springs at Bell Smith Springs Scenic Area, Shawnee National Forest [N 1/2 NE 1/4 NE 1/4 SE 1/4 SEC. 33, T. 11 S., R. 5 E., 3rd P.M., Pope County; Stonefort 7.5-minute Quadrangle (37088E6)].

CAUTION: There are high, ungarded cliffs here and many loose rocks. LOOK where you are going! Do NOT throw or roll rocks.

Bell Smith Springs Scenic Area lies nearly two miles southeast of the drainage divide separating streams flowing north and east to the Ohio River via the Saline River from streams flowing south and east to the Ohio via Bay Creek. Streams here have incised themselves deeply through the thin soil and loess into the underlying Pennsylvanian bedrock. The upper slopes here are underlain by thin-bedded sandstones and siltstones of the Abbott Formation. However, the base of these high slopes terminates abruptly at the brink of precipitous cliffs 60 to 70 feet high formed by the massive Pounds Sandstone Member of the Caseyville Formation.

The natural bridge is located on the southeast side of Bay Creek about 500 feet up-stream from the junction of its tributary, Spring Branch. This is the largest natural bridge reported in Illinois, being about 150 feet long, 30 feet wide, and about 60 feet high. At one time, water from the upland flowed across the lip of the cliff on the outside of what is now the bridge and

helped to excavate a rock shelter in the Drury Shale Member at the base of the cliff. Eventually, a joint, about 30 feet or more back from the cliff, began to intercept some of the water and funneled it downward behind the cliff face. As time passed, the joint was enlarged and more water could be diverted to speed up the erosion process here. Eventually, the enlarged joint intersected the rock shelter and helped to flush some of the shale and smaller rock debris out of it to form the natural bridge. The bridge will last naturally until such time as the end supports are eroded away.

A large rock shelter has been formed near the base of the cliff below the road turn-around near the parking area for the natural bridge. Stone stairs have been constructed down to the base of the cliff from the parking area. The rock shelter is at the bottom of the steps.

Springs have formed where surface water has percolated down through the porous sandstone until it has met with the impermeable Drury Shale. The water then has moved laterally until it has intersected the valley wall, appearing as a series of springs of varying flow rates.

Water seeping along the interface between the sandstone and the underlying shale has kept the shale wet and slippery. Thus, as intersecting joints in the sandstone slowly become enlarged, more water can be admitted to the confined area to mechanically erode the shale and help to produce rounded slopes under the edge of the large sandstone blocks. Eventually, freeze-thaw expansion and contraction, combined with slow gravity sliding, causes some of these large blocks to become detached or else fall over. You can see a number of examples of these processes in this area.

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*Out of Print

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

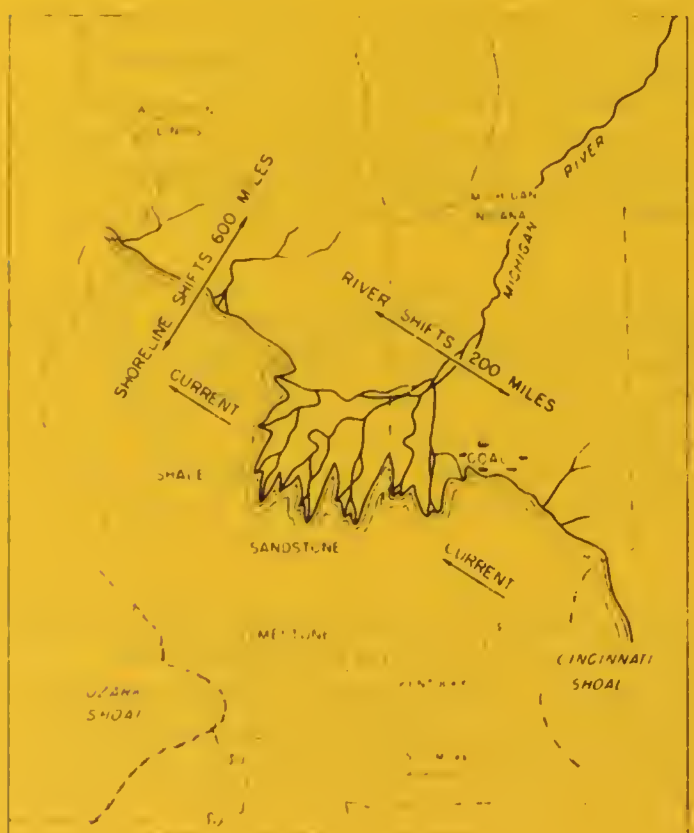
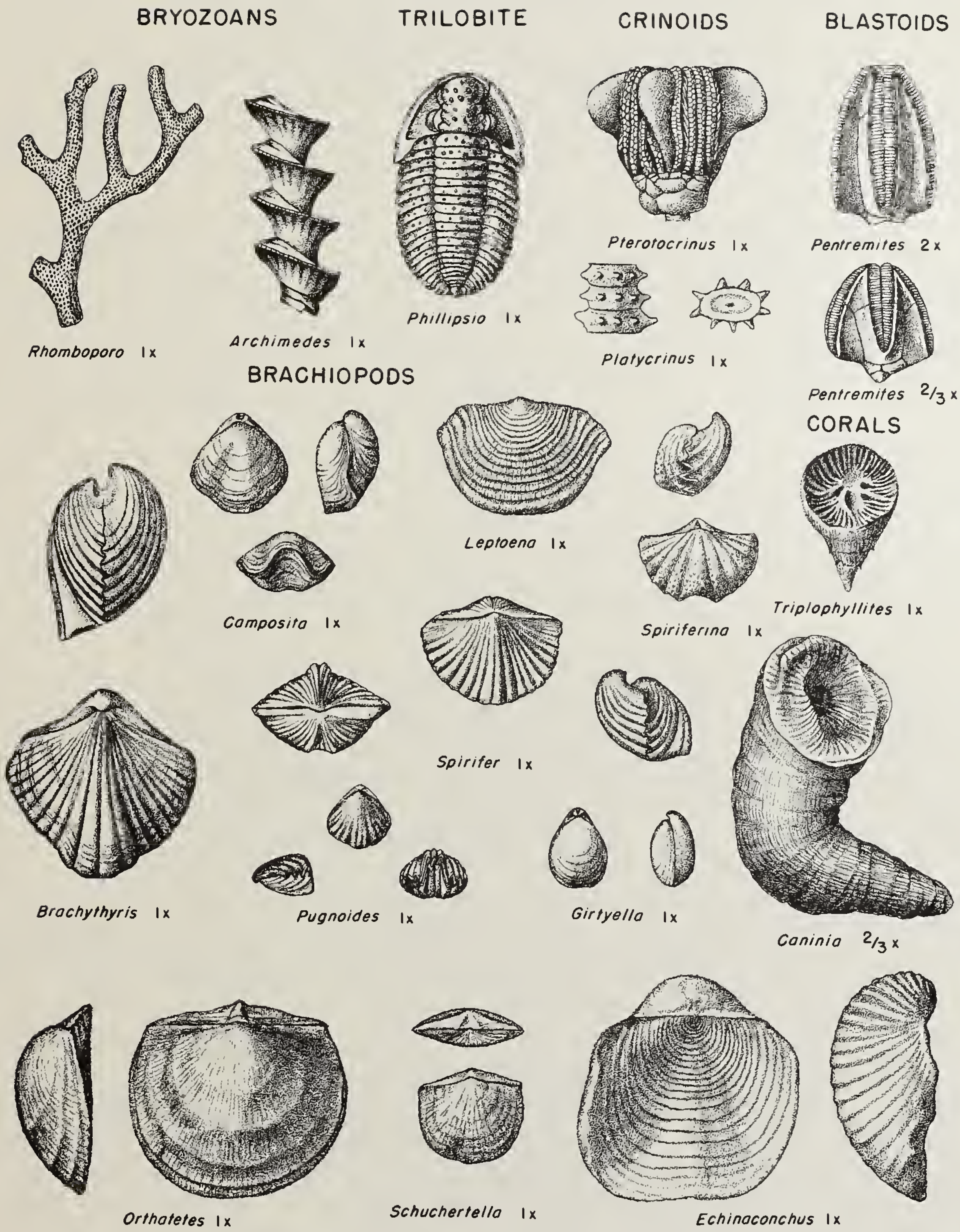


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.



BRYOZOANS
TRILOBITE
CRINOIDS
BLASTOIDS
Pterocrinus 1x
Pentremites 2x
Platycrinus 1x
Rhombopora 1x
Archimedes 1x
Phillipsia 1x
Pentremites 2/3x
BRACHIOPODS
CORALS
Leptaena 1x
Composita 1x
Triplophyllites 1x
Spiriferina 1x
Spirifer 1x
Brachythyris 1x
Pugnoides 1x
Girtyella 1x
Caninia 2/3x
Orthotetes 1x
Schuchertella 1x
Echinaconchus 1x

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

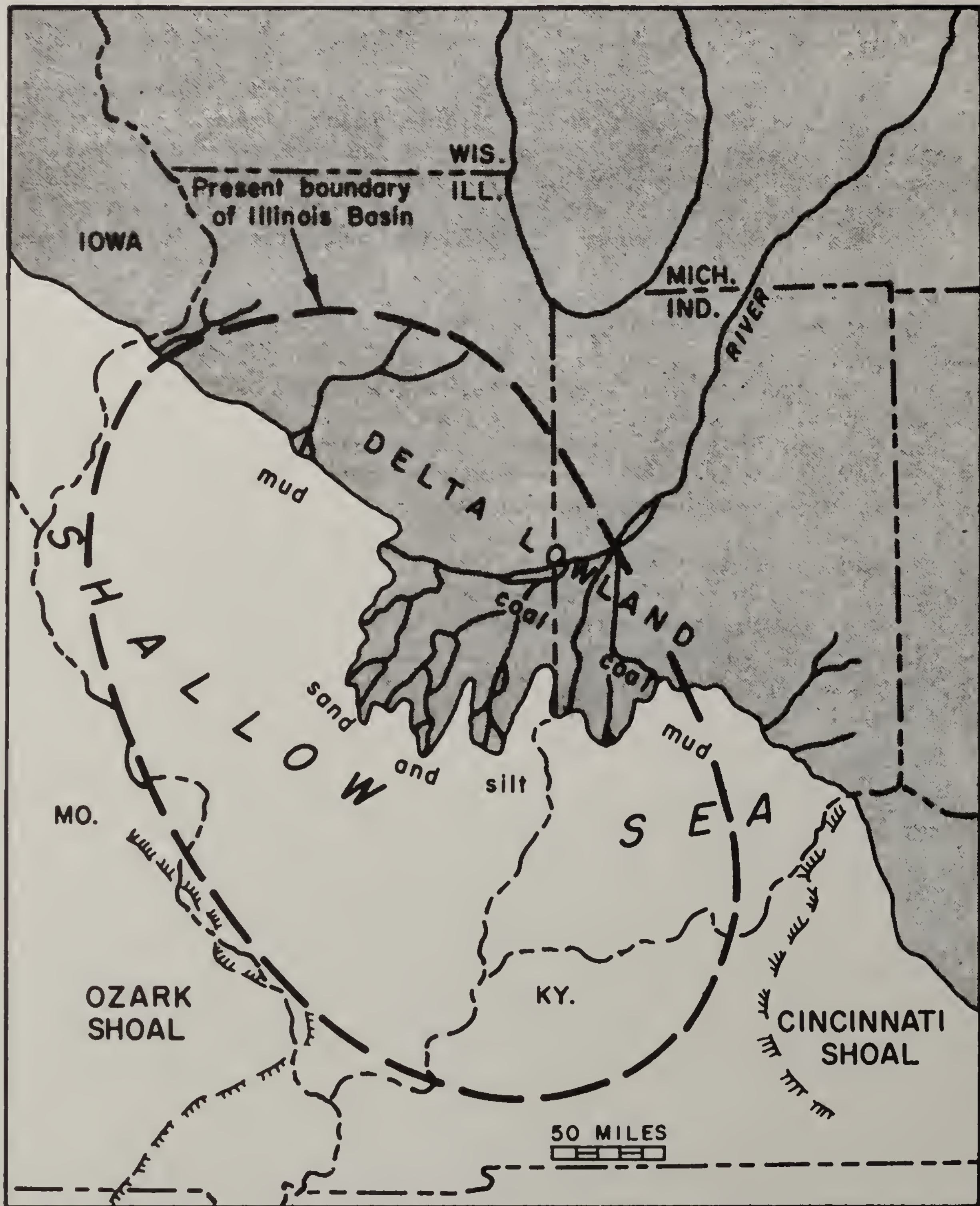
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Fresh-water limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and

limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead, the junglelike forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

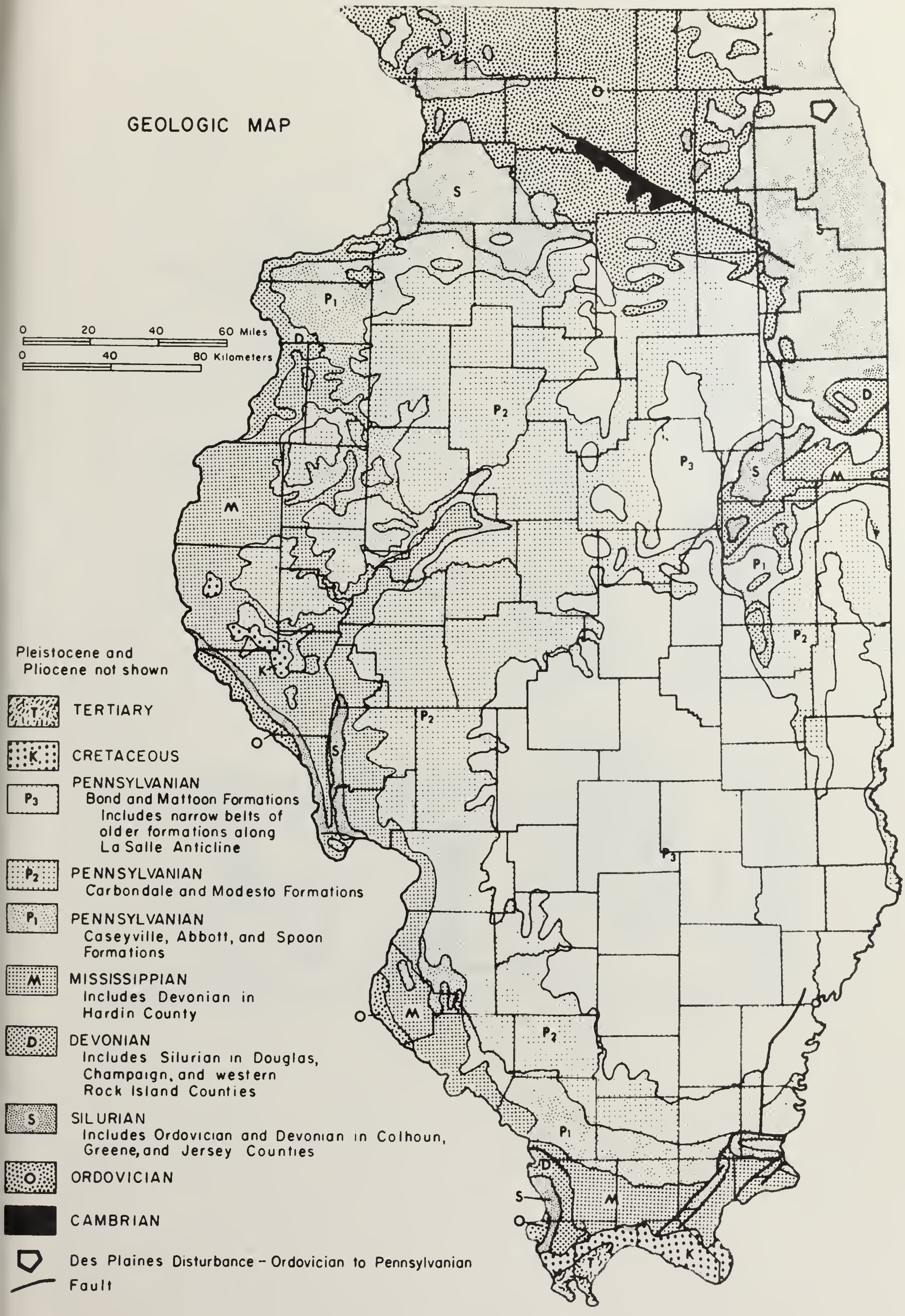
Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

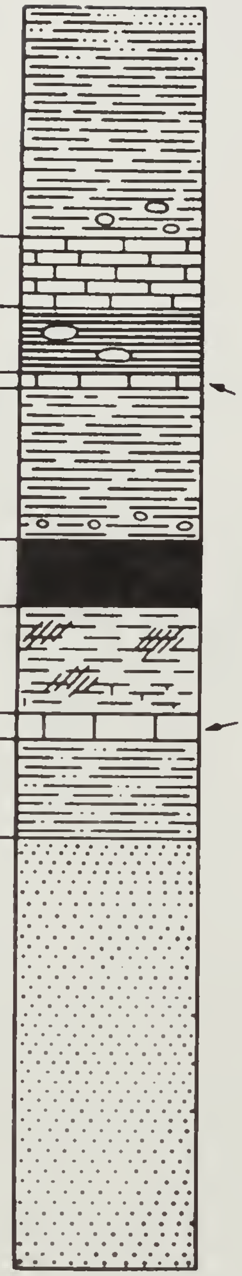
Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in.quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

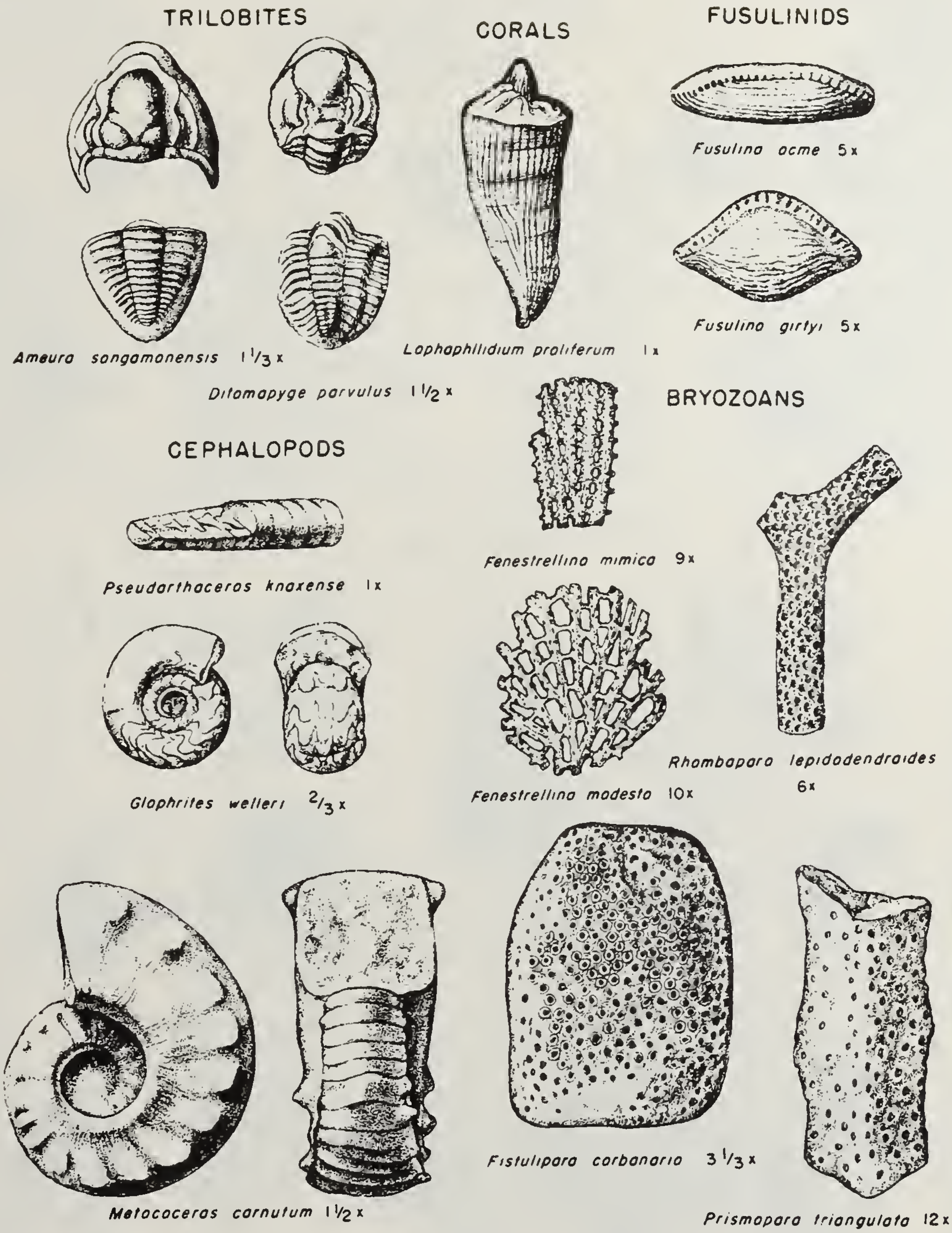


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and Pliocene not shown
TERTIARY
CRETACEOUS
PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline
PENNSYLVANIAN
Carbondale and Modesto Formations
PENNSYLVANIAN
Caseyville, Abbott, and Spoon Formations
MISSISSIPPIAN
Includes Devonian in Hardin County
DEVONIAN
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
SILURIAN
Includes Ordovician and Devonian in Colhoun, Greene, and Jersey Counties
ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance – Ordovician to Pennsylvanian
Fault



AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis 1 1/3 x
Lophophyllidium proliferum 1x
Ditomopyge parvulus 1 1/2 x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1x
Fenestrellina mimica 9x
Glaphrites welleri 2/3 x
Fenestrellina modesta 10x
Rhombopora lepidodendroides 6x
Fistulipora carbonaria 3 1/3 x
Metacoceras cornutum 1 1/2 x
Prismopora triangulata 12x

PELECYPODS

Nucula (Nuculopsis) girtyi 1x

Edmonia ovata 2x

Astartella concentrica 1x

Dunbarella knighti 1½x

Cardiomorpha missouriensis "Type A" 1x

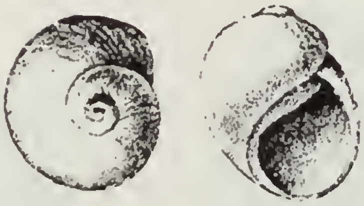
Cardiomorpha missouriensis "Type B" 1½x

GASTROPODS

Euphemites carbonarius 1½x

Trepospira illinoisensis 1½x

Donaldina robusta 8x



Naticapsis (Jedria) ventricosa 1½x

Trepospira sphaerulata 1x

Knightites montfortianus 2x

Glabracingulum (Glabracingulum) grayvillense 3x

FOSSIL PLANTS, FRANCIS CREEK SHALE

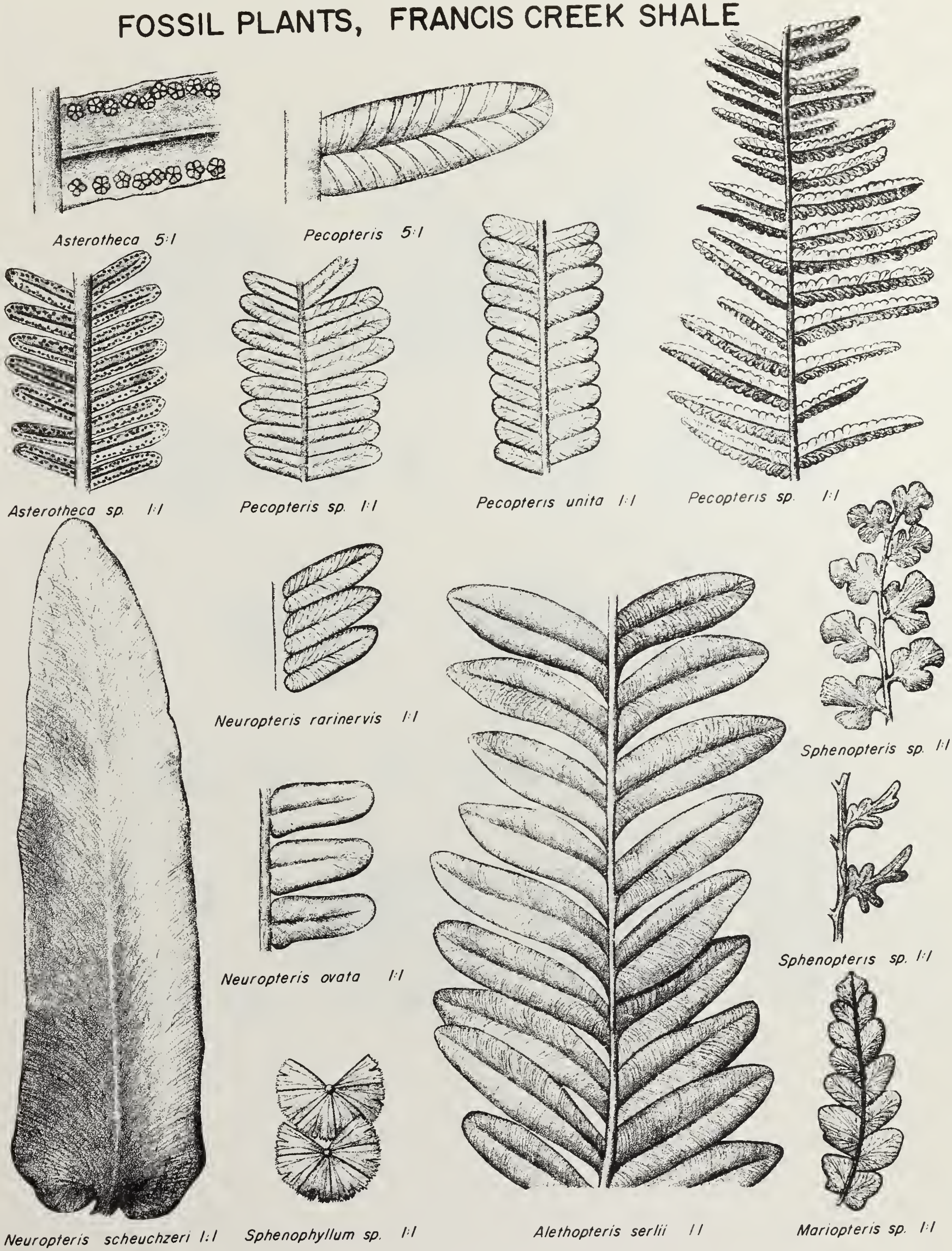
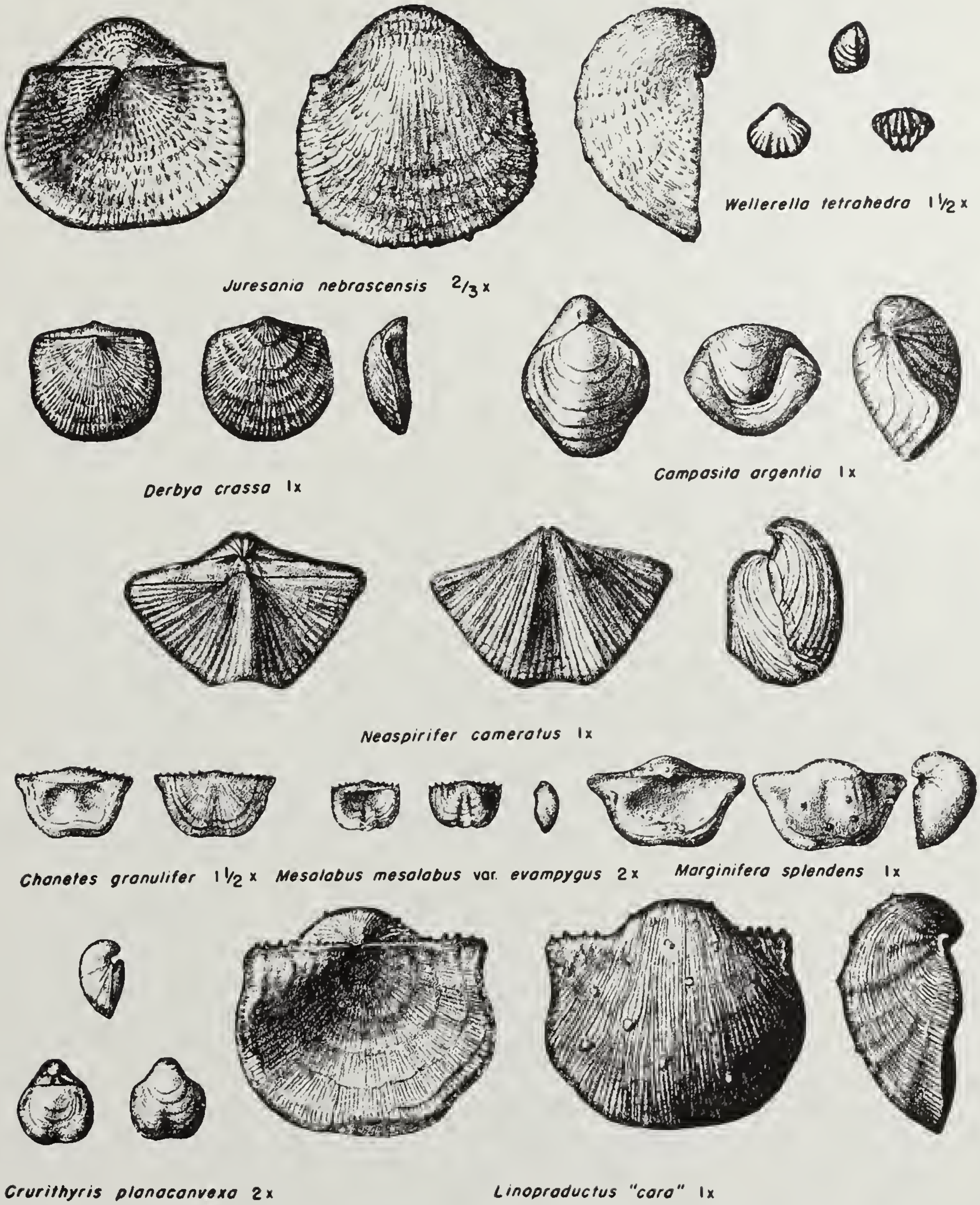
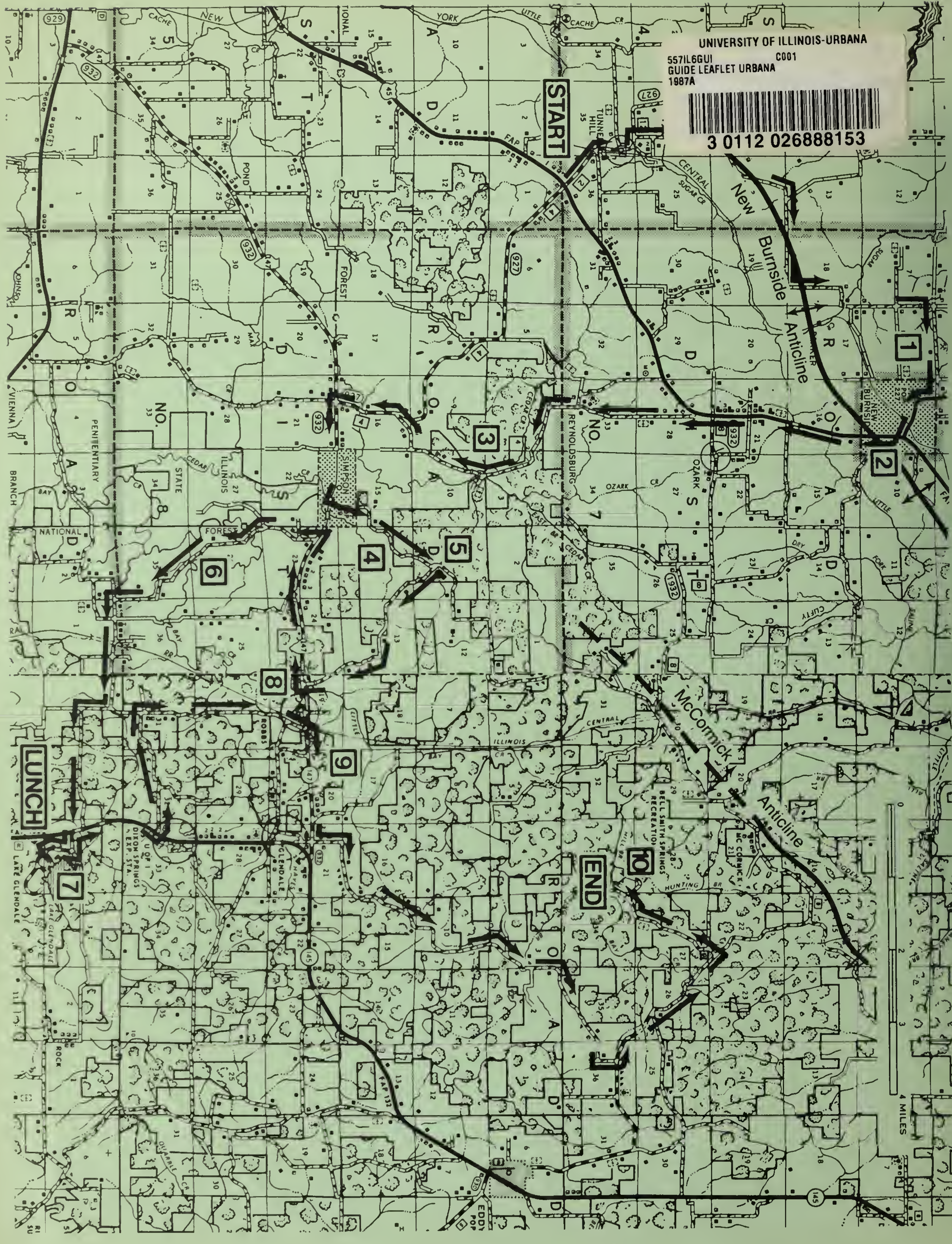


PLATE 3
(corrected)

BRACHIOPODS




START
LUNCH
END
New Burnside Anticline
McCormick Anticline
1
2
3
4
5
6
7
8
9
10
4 MILES